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Metrology and Standardization in Less-Developed Countries: The Role of a National Capability for Industrializing Economies

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UNITED STATES DEPARTMENT COMMERCE • Maurice H. Stans, *Secretary*
U.S. NATIONAL BUREAU OF STANDARDS • Lewis M. Branscomb, *Director*

Metrology and Standardization in Less-Developed Countries: The Role of a National Capability for Industrializing Economies

Proceedings of a Seminar

Held at Airlie House, Warrenton, Virginia

February 1-4, 1971

Edited by
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Washington, D.C. 20234

Organized by the Agency for International Development and the National Bureau of Standards with the cooperation of the National Academy of Sciences and the National Academy of Engineering

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FOREWORD

Industrialization of a developing economy calls for a technological infrastructure to deal with problems of stimulating enterprise, assessing alternative courses, choosing manufacturing methods, and controlling product quality. In these tasks, measurement science and engineering standardization have an important role; yet with different governmental philosophies and economic structures, the needs and priorities of government action will vary greatly.

The National Bureau of Standards has been considering how its experience in metrology and standardization could be employed in collaboration with the U.S. Agency for International Development for assisting less developed countries to build up their own technological infrastructures. The NBS itself seeks an understanding of how its services to the science and industry of the U.S.A. should best be managed. In this self-evaluation we find ourselves working in parallel and in close sympathy with all industrializing nations of the world.

The Seminar reported here concerns the problems faced by less developed countries seeking industrialization. With financial support from U.S. AID, thirteen expert participants from abroad came to express their views on possible relevance of NBS programs. Discussions took place in the light of findings of such organizations as the United Nations Advisory Committee on the Application of Science and Technology to Development, and the 1969 UNIDO Symposium on Industrial Development. In each of eight sessions, several invited papers were presented, followed by informal discussion which ranged widely among diverse viewpoints. We are especially grateful to our guests for their full and frank comments.

We at NBS feel the Seminar made a contribution that deserves the record inherent in these Proceedings. However, caution is the best advice NBS has to offer. Developing nations should not be over-awed by the achievements of industrialized nations and those of metrological laboratories like NBS; they should not necessarily aim at imitating the supposedly successful centers. One needs to realize that ideal solutions are rarely found by any industry or any nation. Often the solution of one problem creates a new unsuspected future problem. However, even if this country cannot solve the problems of other nations, we can all work more effectively by comparing techniques, attitudes, and interests as we have done during the course of this Seminar.

So many organizations and individuals have contributed to the Seminar that proper acknowledgements would be unduly long. I want only to single out the Scientific Apparatus Makers Association, which arranged a post-Seminar tour of several U.S.A. manufacturing plants for our overseas guests.

To all participants, I give my hearty thanks.

LEWIS M. BRANSCOMB
Director

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SESSION 1 - PERSPECTIVE

Paper 1.1 - Objectives of the Seminar

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Washington, D. C. 20523

For many months my colleagues in the Agency for International Development have worked with our good friends, the National Bureau of Standards and the National Academy of Sciences, to plan a meeting which would lay the groundwork for an effective technical assistance program in standards, metrology, and quality control. Now it is my pleasure to be able to welcome and thank all of you who are sharing your valuable time with us this week. Because any such program has no purpose unless it is directly applicable to the genuine problems of industrialization in the developing countries, we are particularly grateful to those of you from Africa, Asia, and Latin America who are able to join us for this discussion.

What is our interest? The Agency for International Development is responsible for United States foreign economic assistance programs. This activity has many components--all guided by the general policy of "...assisting peoples of the world in their efforts toward economic development and internal and external security."[1] The component that brings us together today is that of technical assistance, directed toward the development of a sound and competitive industrial element in the developing countries.

The whole field of foreign assistance efforts by the United States is currently receiving new attention, designed to draw on the lessons of the past to gear our efforts to changing needs and to strengthen them. In his recent message to Congress[2] President Nixon proposed "a major transformation in our foreign assistance programs", creating "separate organizational arrangements for each component of our assistance effort: security assistance, humanitarian assistance, and development assistance." He proposed that development assistance be carried out by two new and independent institutions:

> "A U. S. International Development Corporation, to bring vitality and innovation to our bilateral lending activities...
>
> A U. S. International Development Institute to bring the genius of U. S. science and technology to bear on the problems of development, to help build research and training competence in the lower income countries themselves, and to offer cooperation in international efforts dealing with such problems as population and employment."

These proposals are still being developed and Congress has not yet commenced hearings on them. Whatever their ultimate shape, the topic you will be discussing for the next three days fits well with the emphasis on science and technology that the President has mentioned in connection with the new International Development Institute.

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[1] Foreign Assistance Act of 1961 as amended.

[2] "Foreign Assistance for the Seventies", President Nixon's Message to the Congress, September 15, 1970.

For most developing as well as developed nations, an increasing rate of economic growth has become a major national goal--both to meet rising aspirations for a better life for rapidly growing populations, and to permit effective participation in the increasingly interdependent international community. Achieving more rapid growth depends on three factors. One is the rate at which productive resources can be accumulated, by domestic savings or from foreign sources. Another and more powerful factor is improvement in the use of the productive resources already available (including manpower)--that is, combining them in better ways to produce more economic and social development. Finally, improved technology--defined as the systematic application of science to useful purposes--is a critical component, providing both a stimulus and a means to achieve better use of available resources.

My experiences in development work suggest to me that standards work suffers an appreciation of its value, relative to its actual value, that is one of the lowest among the various branches of industrial activity. Yet standards, specifications, metrology, and quality control have become essential elements of industry and commerce in all developed countries. For example, the recently accelerated rate of growth of GNP in Japan could only have followed an intensive program to introduce these elements. Without the foundation of standards--without the concept and capability to generate predictable as well as standard performance--mass production and the development of a sound internal industry, to say nothing of a mature export capability, are virtually inconceivable.

On the other hand, the concept of standards is one of the most difficult to introduce in the early stages of industrialization. Perhaps this is because many of its effects are indirect--with the relationship between action and benefits being difficult to perceive. Whatever the reasons, the lack of a comprehensive standards framework on which to weave the fabric of industry and commerce severely handicaps many developing countries.

As you know, the level of standards practices--including quality control--is a major determinant of production costs, of marketing capabilities at home and abroad, and of consumer satisfaction. Indeed, the whole process of industrialization rests on the basic productive concepts of fuller and higher quality division of labor, and on its corollary of economies of scale, which in turn rest on maintenance of effective standards. Even where the importance of standards is recognized, there may be a shortcoming in identifying and providing the needed capabilities to achieve standards appropriate to the specific level of development.

In the past there have been occasional requests from developing countries for assistance in building their standards capabilities, and AID has drawn on the outstanding capabilities of the National Bureau of Standards to respond. For example, between 1963 and 1967, NBS provided substantial help, in a variety of forms, for development of the Colombian Standards Institute; and an NBS team sent to Korea in 1967 developed recommendations that have been applied successfully by that country. However, such efforts have been few and scattered, and they have dealt with fragments of the overall standards problem. As in other fields, there have been difficulties also in tailoring training programs in the U. S. to fit well with the opportunities and support that can be expected when the trainees return home.

This brings us to the purpose of this Seminar. That purpose is to explore the comparative worth of building a continuing program and capability for assisting developing countries' efforts to improve their standards work--a program that would be broader and more systematic than past efforts and that would be centered around the established capabilities of NBS. Subject to your advice, its components could include such elements as (a) training technical specialists from the developing countries, (b) indoctrinating managers, planners, and financial people responsible for developing the standards infrastructure, (c) assisting in surveys of potential benefits from standards programs in developing countries, (d) responding to requests for follow-on technical assistance, including possible participation in adaptive or operational research to identify and prove out locally suitable methods.

To help us explore this broad question, NBS has brought together specialists from the developing countries, the U. S., and multi-lateral agencies to examine the special needs and experience of the developing countries in relation to industrial standards, specifications, and quality control.

We hope you will help us to determine:

(1) whether there is real and high priority need for a broad program, recognizing that there are many competing claims for the scarce resources available to the developing countries and to AID;

(2) what kinds of people might benefit from it--technicians, businessmen, government planners, financial people;

(3) how a program in this field should be structured.

In the next three days we hope that you will examine such issues as:

a. What types of standards and standards programs are needed at various levels of development? Which are the highest priority components?

b. Are there minimum standards and metrological capabilities that every country should have regardless of its state of development and, if so, what are they?

c. What are the consequences if a country does not have an effective standards program? How serious are they, compared to other needs, as seen from different points of view, e.g., individual businessmen, Ministers of Finance or Trade, foreign investors, politicians?

d. What problems and barriers have been encountered in developing standards programs?

e. What procedures and organizational structures have been found to be effective in a standards program?

f. What types of resources of manpower, equipment, and facilities are required?

g. What are the problems in developing broad national interest in a standards capability and in obtaining the necessary resources?

Let me emphasize that we have really asked our overseas guests here not so much to learn as to help us. Recognizing that problems of developing countries may be different from ours, we want experts from these countries to play a major role in answering our questions. We also want experts from the U. S. and other more developed countries to bring their varied experience to bear. The joint product should be considerably richer than either group could produce alone.

So you see why we value and appreciate the participation of each organization and individual. I look forward at the end of the seminar to your conclusions and recommendations, which will play a major part in determining:

(1) whether AID and NBS will move forward with a program;

(2) if so, what its character and nature will be.

Allow me to caution you all once more to emphasize the local conditions and problems in the developing countries, and let me close by expressing my thanks and best wishes for a lively and productive session.

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Proceedings of a Seminar, 1971.

Paper 1.2 - Expectations from the Seminar

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The National Bureau of Standards, having been founded in 1901, has grown up with the United States. The functions of NBS, very broadly defined in the statutes, are to assist industry, universities, and individuals in the United States with technical matters. However, the actual programs have been an evolutionary product of the political and technical traditions of the country. Our role is predicated on several principles; a maximum reliance on private sector initiative, a maximum opportunity for technical evolution, and a high degree of pragmatism in finding the right role for a central federal establishment concerned with putting science to work efficiently for national purposes. Changing times have constantly required a reevaluation of these principles, and we are today, perhaps more than ever before, engaged in serious efforts to understand and identify the highest priority central science and technology services that the country needs for the development of its civil economy.

We at NBS do not look on our responsibilities as discharged simply by maintaining a set of national measurement standards or carrying on any other specifically defined activity. We view our responsibility as the identification of those functions that must be provided at national governmental level without which the technological capabilities of the country cannot be applied with maximum efficiency to national purposes. Thus we need to challenge constantly the assumptions on which our present activities rest.

Perhaps the name of our organization, the National Bureau of Standards, is a handicap in this respect, because a "standard" to most laymen is an object whose utility increases in inverse proportions to its use. In other words, if the standard is a meter bar, it is likely to remain stable if you leave it locked up in a safe. That reminds me of a company in the United States which was part of a corporate network, each company in the network having a standards laboratory. One company had responsibility for maintaining surveillance over the accuracy of the secondary standards in the member companies and each of the standards managers in the member companies vied with one another for a good record. One laboratory was consistently the winner. Its instruments were precisely the same and right on calibration each year they were checked. Finally it was discovered that this company had, with some money under the table, bought a second set of standards for actual use, and the ones that they sent back to the primary laboratory were merely resubmitted every year in the unopened box. Their excellent record obviously contributed nothing whatever to the quality control of that operation.

The word "standard" in English covers a set of meanings for which, in French, there are three words. I think it important for us to distinguish between standards of measurement, commercial and engineering standards, and the use of the word "standard" as an identification of a specific acceptance of level of performance. We must always ask ourselves, what is the function of a standards program and do we have adequate measures of whether this function is being adequately carried out? This is not a simple matter, in part because the value of engineering standards and measurements standards lies in part in their contribution to confidence in a system of exchange of both goods and ideas.

Standards are important to the maintenance of quality. They may be important to the making of wise tactical and strategic technical or business decisions. Where confidence and quality are objectives, measures of effectiveness are often hard to come by. Measures are also difficult because we are not dealing with a purely technical subject. Engineering standards, for example, are the product of a negotiation between technical people, each representing a commercial interest. If a standard is to be agreed upon, then compromise and negotiation are required. The result is rarely a technical optimum, but hopefully it is an optimum with respect to the efficiency of the overall system of the uses of technology and enhancement of trade. This is true both in internal standards development within a country and at the international level.

The NBS constitutes roughly two-tenths of one percent of the research and development activity in this country, or seven-hundredths of a percent of the GNP. Yet we are probably the government agency most centrally concerned with the national system of civil technology. It is a result of this responsibility, I believe, that there is such widespread interest in the NBS on the part of government officials and technical people in other nations. Indeed, we at NBS, when we are feeling particularly discouraged, often find that if we would just go abroad we would find that the NBS is well understood and appreciated in a way that it is not always understood and appreciated at home.

Like the Department of Agriculture, perhaps, but unlike most Federal R & D agencies, we do have substantial working contact with less sophisticated customers in the United States. We have many programs that bring us into direct contact with officials at state and local levels whose responsibilities include the regulation of technology through the enforcement of building and fire regulations and things of this character. Our Office of Weights and Measures provides a central technical service to each of the 50 states, assisting them to fulfill their constitutional responsibilities to regulate weights and measures in order to ensure both fair and honest trade. This service also ensures that manufacturers can sell to a national market in which the weights and measures are sufficiently uniform that a single product will meet the legal requirements of all the states. Some of these state capabilities are rather primitive on modern technological scales. Nonetheless, they serve a useful function and they are carried out in an exceedingly economical fashion in view of limited state budgets. Our Technical Analysis Division has gained extensive experience in assisting officials at local levels with the management sciences, rather broadly construed, and have a feeling for the sort of problems that arise when massive R & D capabilities are not readily available.

The NBS staff has participated extensively in overseas activity at the request of the Agency for International Development and other international agencies. Although these experiences have been rewarding for our staff members who participated, we have not achieved a very good institutional learning capability from this experience. We do not pass the experience on effectively from one man to the next. We do not have a very clear-cut policy for deciding when we can respond to a request or at what level of effort. Nonetheless we feel that these contacts are important. Of equal importance is the very large number of technical visitors who come and reside in our laboratories for a period of a month to a year or two. We have as many as 70 such people each year, coming from dozens of countries, and this has given us a useful working level contact with the technical problems of many different nations and cultures. Secretary of Commerce Maurice Stans, on a recent trip to South America, announced the intention to inaugurate a Standards Fellowship Program for Latin America. Under this program NBS will make available whatever capability we have to assist in providing participants with a useful experience in the United States in connection with engineering standards activities. This is a program which has just begun. We are just feeling our way.

One of our hopes from this meeting is that we will gain a clearer insight on how we can be useful in this kind of activity. More fundamentally, we really would like to understand better the need of the industrial technological infrastructure of a country for central technical services. Indeed, what do we know of these needs in the United States itself? If we do not understand that well, what of the requirements of countries in other stages of industrial development? Should contemporary societies less wealthy than our own, and perhaps less plagued with some of the problems that result from poorly used wealth, follow a similar pattern to that followed by the United States with respect to these central technological services? I seriously doubt if that would be wise. Indeed, I doubt that it is even possible, and certainly not necessary. The same historical pattern need not be repeated, and indeed if we had it to do over again we would very likely not follow the pattern that the United States did follow in the last 50 years. How might the NBS contribute to such understanding and contribute to the programs that result from that understanding? It has often occurred to me that NBS has sister institutions in other industrialized nations with whom we have the most cordial and close working contact, with whom we could collaborate much more effectively in activities helpful to the developing nations. I am thinking of the National Research Council in Canada, the National Physical Laboratory in England, the Physikalisch-Technische Bundesanstalt of West Germany, Bureau Nationale de Métrologie of France, the TNO in The Netherlands, and the equivalent laboratories in the U.S.S.R. and in Japan. These major laboratories constitute the central core of activities in the International Committee of Weights and Measures (CIPM) which is the instrument of the General Conference of Weights and Measures and which carries out its activities. CIPM also maintains a central measurement laboratory, the International Bureau of Weights and Measures (BIPM), near Paris. There are 43 nations that belong to the CIPM, and most of them are not the highly developed industrial nations I just mentioned. I question whether CIPM and the central laboratories, the BIPM, serve all of these member states as well as they might; but how could they serve better? If we could come to a better understanding of that question I believe we could take steps to ensure that this international laboratory does better serve the nations of the world that participate.

I am personally very grateful to the National Academies of Sciences and Engineering and especially to AID and, even more especially, to those of you who have come from long distances to give us a chance to learn at this meeting. We hope that we will learn where we can put our priorities of time and talent to help aid international bodies in this worldwide program of development cooperation. Perhaps we can use our influence to further those constructive multi-lateral and international endeavors that are judged to be important.

It is important that you appreciate that we at NBS have a laboratory of technical people. We have very little legal authority in the compulsory sense of that word. Our work must be needed by our client in order to be used. We do not enforce any measurement standard in the United States. We issue very few engineering standards. We do not do product engineering. We do not assume management responsibility for enterprises. However, in every one of these areas we are deeply involved in research and analysis, understanding and observation. We view the technological system in some sense from the outside. We hope we can be objective about it. We feel we can be practical about it. I believe that, if we are successful in some moderate participation in the improvement of the central technical services to developing industrial economies, we may, out of that experience, better understand how we can serve our own people in this country. Our responsibility for the coordination of a compatible and accurate national system of measurement, of course, also calls for a system that is harmonized internationally, because a measurement system that is not harmonized internationally is not useful nationally. This strong international orientation that our central responsibility gives us automatically brings to our staff a

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strong interest in the international work that is the subject of this discussion. I can assure you that the management of NBS will give the strongest encouragement to whatever practical and constructive programs emerge from these and subsequent discussions.

Paper 1.3 - Keynote Address - The Role of a National Capability in Metrology and Standardization in Industrializing Economies

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Washington, D. C. 20006

In considering "The Role of the National Capability in Metrology and Standardization in Industrializing Economies" we must examine the development, structure and services of similar capabilities in the more advanced countries. No one can afford the luxury of not profiting from historical successes and failures of others.

Before we examine some of the aspects of our concern, I wish to read a quotation that has haunted me since I first heard it at the age of fifteen. It is from the writings of a brilliant, inspired, and inspiring man named Henry Grady--a man who has greatly affected the history of the United States but whose name will be new to everyone here, unless you lived some years ago in Georgia or unless you are a scholar of Southern history.

"A few years ago I told, in a speech, of a burial in Pickens County, Georgia. The grave was dug through solid marble, but the marble headstone came from Vermont. It was in a pine wilderness, but the pine coffin came from Cincinnati. The iron mountain overshadowed it, but the coffin nails and screws and the shovels came from Pittsburgh. With hard woods and metals abounding, the corpse was hauled on a wagon from South Bend, Indiana. A hickory grove grew near by, but the pick and shovel handles came from New York. The cotton shirt on the dead man came from Cincinnati, the coat and breeches from Chicago, the shoes from Boston; the folded hands were encased in white gloves from New York, and round the poor neck, that had worn all its living days the bondage of lost opportunity, was twisted a cheap cravat from Philadelphia. That country, so rich in underdeveloped resources, furnished nothing for the funeral except the corpse and the hole in the ground, and would probably have imported both of those if it could have done so. And as the poor fellow was lowered to his rest, on coffin bands from Lowell, he carried nothing into the new world as a reminder of his home in this, save the halted blood in his veins, the chilled marrow in his bones, and the echo of the dull clods that fell on his coffin lid.

"There are now more than $3,000,000 invested in marble quarries and machinery around that grave. Its pitiful loneliness is broken with the rumble of ponderous machines, and a strange tumult pervades the wilderness. Twenty miles away, the largest marble-cutting works in the world puts to shame in a thousand shapes its modest headstone. Forty miles away, four coffin factories with their exquisite work tempt the world to die. The iron hills are gashed and swarm with workmen. Forty cotton mills in a near radius weave infinite cloth that neighboring shops make into countless shirts. There are shoe factories, nail factories, shovel and pick factories, and carriage factories, to supply the other wants. And that country can now get up as nice a funeral, native and home-made, as you would wish to have."

When I tell you that Henry Grady made his contribution around the turn of the century, the principal point is, I hope, clear. The industrialization that he exhorted people to, and the beginnings he was so prominent in, have so blossomed in the last 50 years that Henry Grady would be amazed to see the changes in the standard of living, the educational level and the health services of Georgia today.

Given the will and the desire of the people, with leaders of vision and knowledge, the less developed countries can like the state of Georgia in a relatively short period of time achieve the same benefits of industrialization that this Southern State did after it was decimated by civil war. I hope it will be possible at the same time for these countries to escape some of the environmental problems with which the United States is now struggling.

A few years ago I had the interesting experience of hearing, at a small luncheon, the initial concept of the Alliance for Progress. This was tried out on a few of us who were working in Latin American development. On my left was one of the foremost economists of the United States. He remarked to me that he felt no assistance should be given under the proposed alliance to help build national science capabilities. He believed aid should only be given in the application of scientific knowledge resulting from foreign research and that a national scientific infrastructure was a luxury that should be foregone in favor of achieving universal literacy, and other goals of this kind. I replied then as I would today: First, that it did not matter what he or I thought should be done, because each country would have its own science interests; and secondly, it was clear that even the adaptation of which he spoke could not be accomplished without a national capability in science and technology. To show how forcefully this belief is held by the foremost spokesman of Latin American science, I will quote from my esteemed friend Dr. Bernardo Houssay who is the first Nobel laureate in science from the region:

"...If the fundamental scientific research of a country is poor or weak, applied sciences and industrial and agricultural technologies become stagnant, deteriorate or disappear."

Since my experience is primarily with Latin America, I will of necessity use illustrations and data from that region but probably these will apply to other industrializing sections. Why is national infrastructure in science and technology necessary, and what is its effect on the development process? We will probably be able to discuss at greater length what the role of science and technology might be in socio-economic development than what its contributions actually are. The discovery of science as a discipline to be extolled and supported by decision makers is quite recent. Its actual potential and the best way to use it are only now being explored. The Japanese experience, the OECD work with the Mediterranean countries, and the OAS studies in Latin America are still current. Some conclusions are however usually accepted as valid. The only basic wealth any country has is in its people and its physical resources. The exploration, identification, and evaluation of the natural resources of a country require a national scientific capability. To have these studies performed by foreign experts is in most cases too costly and might entail varying degrees of loss of national control. We might remember here that much of the Andean region of South America has not been explored for valuable minerals, much of the interior of South America is untouched by scientific exploration, and perhaps 75% of the plants of the Amazon region are not yet classified.

Just as science and technology are only newly considered in governmental councils, so a working partnership between the economic planners and the scientific community is not yet routine. Yet it is beginning; the scientists and engineers are becoming concerned and are being consulted in the economic plans of several Latin American countries. This combination is now identifying national needs and determining how they can be more adequately met through the use of appropriate technology. So far, however, the benefits of such cooperation in the systematic and intensive determination of national goals are more to be desired than to be enjoyed, but the increasing role of scientists and engineers in the planning process cannot be denied.

Once a decision is made to initiate or to improve an industry, the process to be employed must be decided at least in part on a technological basis. When industries are started or new processes are introduced into existing industries, the most basic and important decisions must be made as to the technological procedures that will be used. These decisions to be sound must at some level be subjected to a scientific analysis based upon the required technical knowledge and experience. A national scientific capability must operate in deciding whether a new technological process should be developed locally or be purchased from abroad. Even before this step, technical knowledge and experience are required in deciding where to look and what to look for.

How real is the need for a scientific infrastructure that grows in strength? How can we justify the expenditure of limited capital in this direction? What is the minimal capability that will insure a profitable and continuing technological effort? On what basis do we even determine the answers to these questions? Although we must face our inability at this time to answer these questions with quantitative precision, we may venture some general conclusions that usually serve as guidelines in developing countries. Even if a country is small and industrialization is little advanced so that all technology is imported, there must exist a national capability that will at least serve as a basis for logical decisions. Once any technical process is begun, there must be the ability to keep it running. For locally owned and managed agriculture and industry, the importation of technical experts eventually proves prohibitive.

One of the most rapidly growing areas in Latin American governments is planning. It is recognized that to the maximum degree possible, the limited human and financial resources must be used in the most efficient way. The luxury of years of trial and error cannot be afforded. I wish I could report that science and technology are an integral part of this planning process in Latin America. I can report that they are becoming more nearly so. In some countries, the voice of the science community is being raised and is being heard. So far, there is not the desirable degree of cooperation between the national planning bodies on the one hand and the universities and the national research councils on the other hand. This is a statement of regrettable fact and not of censure. The planning offices in most countries are only a few years old and except in one or two cases the research councils are even newer. Between five and ten councils have been created in the last three years in Latin America.

Since technology transfer or even more politely, technology exchange, is a current topic of great interest, let us examine the importance of a national capability in this process and particularly in relation to the planning function.

Ideally, the science community would work with the planning offices in the complex policy decisions that must be made. As I have said, this does not now happen often or extensively. On the other hand, policy decisions as to the agricultural and industrial goals and plans of a country cannot be made solely by scientists. The national consequences of such decisions are so vitally important that every appropriate sector should be involved. The complex questions that must be answered require the knowledge of economists, industrialists, and the social scientists, as well as the natural scientists and engineers. How else can valid answers be obtained to such questions as to whether the industry should use a technology that is labor intensive or capital intensive, how soon limited public or private financing should be devoted to the initiation of a certain technology, and what are the social consequences of a decision to go ahead? How else can valid answers be obtained to the complexities of the importation of technology and to all of the elements that comprise the "receptive climate for new technology"?

The eminent Argentine economist, Raul Prebisch, recently characterized technology transfer in Latin America as ambivalent and contradictory in the sense that the need for innovation is great, but the introduction of advanced technology without consideration of existing production systems can result in employment problems and the fixing of scarce capital in sectors of less need. Once such undesirable results are produced, they are difficult to reverse. An example lies in the computer situation. A recent survey made by the OAS showed that expensive equipment is in some locations being used only an hour or so a day.

What are the needs for national capabilities in metrology and standardization in Latin America? Here we must emphasize the trite but still important fact that differences exist in size, economies, and degree of industrialization among the countries. Obviously the needs and capability of Brazil are several magnitudes different from those of the smallest countries that are primarily agricultural.

Although it involves standards of a kind different from those with which we are dealing primarily here, an anecdote might serve to illustrate that the need is universal. In one of the smallest Latin American countries where industries are few and funds for science are greatly restricted, a bright and energetic dean of science campaigned successfully for national food and drug laws. He then used his university laboratories to test the products sold in his country. The fees charged paid for excellent teaching and research equipment and the laboratory now performs these services for other smaller countries in his region.

As the industrialization of Latin America increases so does the awareness of accurate measurements and recognized standards. As the trend towards common markets and the manufacture and international sale of products from native raw materials grows so does the interest in metrology and standards. The Latin American Free Trade Association is greatly concerned with the introduction of standards that will be recognized throughout the hemisphere. Thought is being given to the development of a certifying seal that would be adopted by all the members of that organization. The Andean common market countries have the same interests and plans.

The extent to which metrology and standardization can be supported on a national basis is an individual matter for each country. The services required and those to be rendered by a national capability must be determined in the context of the total country needs and the financial and scientific resources available. The question then is not whether this capability is desirable but rather what is the structure and which are the services that are appropriate.

For those countries that cannot have at present the metrology and standards services they wish, one possible solution is in a regional approach. Just as the Central American countries have joined their interests and resources in the Central American Institute of Technological Research, in the Central American Institute of Nutrition, and in the Central American Association of Universities, and just as some of the Caribbean countries have a central university, so might the smaller countries of a region band together in metrology and standards.

In this Seminar we have an excellent opportunity of exchanging ideas and experiences concerning the fundamental structures, missions, goals, and results of the organizations you represent. We might consider such questions as:

(1) What elements are considered in determining the areas of active interest and what is the process for arriving at these decisions?

(2) How is it assured that the work meets the needs of government and private industry?

(3) What mechanisms exist for getting appropriate information to the user?

(4) How are charges, if any, for services determined?

(5) How is and how could cooperation among governments be arranged and augmented?

I am sure that each of you has additional questions you wish to raise and information and experience you wish to share. I look forward with pleasure to exploring our common interests and to the development of specific plans for increasingly productive cooperation among the countries and organizations represented here.

Paper 1.4 - NBS Programs to Provide Infrastructure Services for Science and Technology in USA

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I shall try to build upon the remarks of earlier speakers, particularly Dr. Branscomb, who did tell you quite a bit about the National Bureau of Standards. I shall go into greater detail about some of our programs, stressing the variety of activities in which we are engaged, and the multiplicity of ways in which we try to serve the scientific and technical activities of the USA.

The title of this paper is a rather formidable--"NBS Programs to Provide Infrastructure Services for Science and Technology in USA." The explicit reference to the infrastructure of science and technology is, however, quite deliberate. Economists use the term--infrastructure--to mean those services, such as transport, power, education, health, in which a society makes a long-term capital investment, and which investments may not themselves return a profit. They are social or public overhead capital and are usually publicly funded for that reason. By analogy, one can say that a country's scientific and technological endeavors also are supported by an infrastructure, including its system for educating scientists, its specialized channels for communication of scientific and technical information, and its provision for metrological and standardization services. It is also true that the health and effectiveness of these services is an important factor in determining the vitality of the science and technology in that country. As infrastructure services, these too may be publicly supported.

Indeed, the last of these, the provision of metrological and standardization services, was explicitly the reason for the creation of the NBS in 1901. We have a strong conviction that the NBS is an important part of science and technology of the USA and that the Congress was wise to have created it when it did. But, except in a limited number of cases, we have little quantitative knowledge of the direct economic impact of our programs. We do know that all of our programs have enthusiastic constituencies; we learn about this when we try to stop one. However, the extent of this enthusiasm is really no indicator of the relative importance of the particular program.

I am going to describe to you the many metrological and related services which are intended to make the conduct of the scientific and technological activities of this country more effective. Although I will describe the multiplicity of services that NBS provides, I am not implying that this display of services in its entirety is the only way to provide what may be needed, even in a country of technological sophistication comparable to the USA, let alone to any less developed country. The set of services I will describe has been developed over a period of many years; even within the NBS we are not satisfied that they constitute the optimum set, and we are continually examining ways in which we can accomplish our purposes more effectively. We are continually eliminating or modifying existing services and introducing new ones.

One of the subsidiary purposes of this talk was alluded to by Dr. Branscomb. That is to counter the rather restricted image of the NBS which may be conveyed by its name. We are concerned with much more than standards, although standards are themselves a very important part of any country's technical capability. It is our concern for the adequacy of the measurement capability of the USA in the broadest possible sense that motivates most of the work that we do at NBS. In addition, we see our role as encompassing assistance in the application of technology in the public interest, though we do not ourselves develop that technology. This is an important point. We do not develop technology for exploitation in the private sector. We do seek to identify and remove the barriers to its development in the scientific and technological activities of the rest of the country.

I also wish to draw attention to the wide range of sophistication and diversity of the services that are required to support a technologically based economy. By displaying this variety of services and programs, I suggest that we at this Seminar may be guided in identifying those that are particularly appropriate for use in a less developed country which is striving to develop the industrial base of its economy. It is not very likely that a carbon copy of the organization of NBS--or even a demagnified version of it--will provide the proper institutional framework within which these services should be provided in a country of markedly different technological development. A less developed country whose economic development is based on an improvement of agricultural technology, or whose industrialization will be based on the processing of agricultural products, may find NBS a very poor model indeed. NBS has played a rather small direct role in the development of agricultural technology. Institutions dwarfing ours in the Department of Agriculture have largely dealt with this.

Another point which Dr. Branscomb mentioned is that NBS represents only a small fraction of the total technical capability which is available in the USA. In the early days of the NBS, to be sure, we represented a somewhat larger fraction than we do today. However, at no time have we had the mismatch between the technical competence in government and that in industry which I suspect exists in most of the less developed countries we might consider. In my limited travels to several countries which are striving to stimulate their industrial development, one of the dominant problems is that the government technical experts, by and large, have no one to talk to in industry.

The usually close match between the NBS technical capability and that in U.S. industry, combined with the limited financial and manpower resources of NBS, have put us into a characteristic mode of operation. Rather than blindly doing things for scientists and engineers in industry, we work with them. We involve them in the work of finding solutions to their measurement problems. Having made this generalization, let me hasten to say that in many instances we do deal and interact with people whose technical skills are quite unsophisticated indeed. Often they are public officials at the county, state, or city level. So in this respect, we do have some experience in working in a mode comparable to what one might expect in a less developed country.

Let me also repeat what Dr. Branscomb mentioned earlier--the NBS has no powers of enforcement. Our mode of operation with scientists in universities and in industrial and other government laboratories is a cooperative and purely voluntary one. We have no authority to order people to do things a particular way. We gain acceptance for our ideas and suggestions only by virtue of their technical soundness and reasonableness.

Our main interest this week is economic development based on the application of science and technology. Let me point out that a vigorous scientific activity in a country is no guarantee of economic development. Even in the USA, there has been concern about the lack of coupling between our basic and our applied research; and the processes through which applied research and development lead to economic growth are poorly understood. Some companies have been notably successful; many more have not. No formula for success has been found, but it will surely involve much more than simply direct investment, government and/or private, in science and technology. Tax policies, regulatory policies, policies to stimulate innovation, and management techniques will all figure importantly.

Now let me discuss the NBS objectives, the resources that we have available for achieving these objectives, and some of our specific programs. The NBS is an element of the U. S. Department of Commerce. The Department of Commerce is broadly dedicated to the stimulation of this country's economic development. Science and technology are an important part of this job. The NBS is one of several technical agencies within the Department of Commerce. We have recently defined our goal: To strengthen and advance the Nation's science and technology and to facilitate their effective application for public benefit. This statement of our goal suggests that we have two operating objectives. The first is assuring an adequate national capability for physical measurement. This is the statutory responsibility of the NBS as given in the 1901 law which established our institution. However, it follows from our performing this first function that we have developed a remarkable set of resources in the physical sciences and engineering. We feel a responsibility to apply these resources to the solution of some of our current national problems. This is our second objective. Not to apply these resources to these very pressing problems, would be a denial of our responsibility as scientists.

Looking further at these operating goals, we see them as meeting our responsibilities to the several sets of customers that we attempt to serve. The first beneficiary is the individual scientist and engineer wherever he may be; we help him do his job better on a day-to-day basis. Our second responsibility concerns using our skills to assist the application of national scientific and technical skills to meet particular problems in industry and government. The third responsibility is to use our services on behalf of buyers and sellers in the marketplaces of the country. The fourth responsibility is in connection with public safety, and the final one relates to services provided for the broad technical community generally.

Now, what are some of the resources that are available to us for achieving these objectives? We have a total staff of approximately 3500 people, 80% of whom are located in our laboratory at Gaithersburg; 17% are located in our laboratory in Boulder, Colorado; and 2% are still at our old laboratory in the District of Columbia. Nearly half of the people on board are scientists and engineers, people engaged directly in technical work; it takes nearly an equal number of support personnel to back up this group. The breakdown of our professional staff I find interesting. The largest single group is physicists, followed by chemists and engineers. Our most rapidly growing group, now amounting to 12%, we call "other professionals." It includes economists, sociologists, psychologists, and lawyers, which suggests something about the types of problems in which we are now becoming engaged; problems that involve subjective measurement factors and that have important economic and social impact--which we must understand if our work is to be effective. The educational level of our staff is remarkably high. Fifty percent of the professionals have advanced degrees; 30% have their doctorates.

The dollar resources that are available to us are not insignificant. In the current fiscal year, we have approximately seventy-four million dollars available, nearly 60% of which comes to us directly from the Congress. Nearly all of the remainder comes to us from other government agencies on whose behalf we undertake particular programs. A small amount of income--4% of the total--comes to us as payment for specific services that we provide, mainly testing and calibration. Let me draw your attention to the fact that the testing and calibration activities, as such, represent a rather small fraction of the total activity of the NBS.

Our facility at Gaithersburg, Maryland, which most of you have seen, comprises 21 buildings with 112,000 square meters of working space. Another laboratory in Boulder, Colorado, is the center of most of our activity in high frequency electrical measurements, low temperature engineering, and work in atomic physics--particularly problems in astrophysics.

The organization chart of these two NBS facilities shows six operating groups. The three major ones are called institutes: The Institute for Basic Standards, which is concerned principally with the physical measurement quantities and related standards; the Institute for Materials Research, which studies chemical and physical properties; and finally, the Institute for Applied Technology, which emphasizes our economic and social concerns. Our Center for Computer Sciences and Technology deals with a specific area--automatic data processing. We have an information program under an Associate Director for Information Programs. Finally, we have the conventional set of administrative activities that support a technical operation.

Let us take a look now at the first operating goal that I mentioned before, that is, assuring that we have an adequate national capability for physical measurement. This includes a number of activities. First, it involves providing national standards of measurement for the important physical measurement quantities. There are approximately 40 of these, starting with the basic four--mass, length, time, and temperature. The other 35 or 38 are related to these four through the laws of physics and constitute a rational set. It is basic to the technical activities of any country that it have adequate physical measurement techniques and standards for these physical measurement quantities. Second, one needs to be concerned with transferring the measurement capability that we have at the NBS to other laboratories throughout the country. Third, one needs to provide reliable reference data for scientists and engineers to use--data which do not need to be continually re-evaluated and rechecked by the individual experimenter or designer before he feels confident in their use. And finally, there is a broad class of measurements that concern the properties of materials. For these we also need adequate and reliable test methods and measurement procedures.

We talk a lot about good measurement at NBS. I want to say a few things about what we mean by good measurement. First, one needs to be certain he knows what property needs to be measured for the application in mind. Then one needs to be concerned that the measurement that is being made is appropriate to determine that property. Having this, one needs to be satisfied that the accuracy with which the measurement is made is appropriate to what the needs are. One needs to be certain that the measurement can be repeated as often as it needs to be and give essentially the same answer. Finally, one has to have some assurance that, if a similar measurement is made in another laboratory, another investigator can obtain essentially the same results.

These then are some of the criteria that we use in the provision of the national standards of measurement, where we are concerned with continually improving the existing methods and improving the existing standards. For instance, the present frequency standard at the NBS Electromagnetic Calibration Center is the cesium beam clock. It has been the national standard for several years. Its performance is continually being improved. Most recently, a statistical analysis of the variation of its performance over a period of time has permitted us to specify with greater degree of precision the accuracy of the signal that it produces. We are continually on the lookout for applying new scientific breakthroughs to measurement problems, particularly in connection with these fundamental standards. For example, the recently discovered Josephson effect in superconductors at extremely low temperatures may provide a new standard for voltage. The most recent field of scientific activity that offers promise for metrology is the field of lasers and laser technology. We expect that in the not too distant future light from a stabilized laser will be the basis of the international standard for both length and frequency. We have a very active program concerned with lasers, specifically for their application to measurement problems. Finally, we are very much concerned with the compatibility of our national measurement standards with the national standards of other countries. To this end, we cooperate enthusiastically in the (international) General Conference of Weights and Measures and support, as we can, the activities of the International Bureau of Weights and Measures.

Of course, we would not be doing our job if the only people in the country who can measure well were all at NBS. We need to be sure that this measurement capability that we have is disseminated to all of the people that need it, including the inspectors of weights and measures in the 50 States. The principal method for accomplishing this is through the testing and the calibration of secondary standards; but we have recently come to the conclusion that simply calibrating secondary standards for a laboratory is no guarantee that the laboratory is going to be able to make good measurements. The question of making a good measurement includes much more than simply the calibration of standards. We have recently undertaken what we call "pilot programs" with a number of cooperating laboratories whose performance in making a particular type of measurement we actually monitor. The two fields in which we are actually operating such programs now are the measurement of mass and that of voltage. Using techniques developed here, the participating laboratories are able to monitor their measurement performance continually so that they can tell whether such things as factors in the environment of the laboratory or a change in operator or in operating procedure is affecting their ability to make a particular measurement. In our measurement analysis program we expect to extend this principle to other physical measurement quantities such as length, temperature, electrical current, and so on.

Finally, another way in which we transfer our measurement capability is through the broadcasting of time and frequency signals which can be picked up in something approaching two-thirds of the world. We have a radio station located in Boulder, Colorado--WWV--and another located in Hawaii--WWVH. We are continually striving for new techniques for disseminating these signals and making them useful to people. We recently developed a technique by which we are using commercial TV as a carrier for timing signals which will permit very accurate synchronization of clocks wherever a commercial TV set and a modest amount of additional equipment are available.

With respect to providing reliable reference data for scientists and engineers, there are two ways in which we do this. First, we can undertake our own careful experiments to provide particular data. Examples would be our precision calorimetric measurements on sapphire and our experiments on the redetermination of the velocity of light. Another way of providing these data is by reviewing critically the data that are available in the literature. To this end we have a Standard Reference Data Program which utilizes the knowledge and skills of many laboratories throughout the USA as well as several outside of the country. Their function is to review critically the world literature in fields in which they have special expertise and to distill from the literature those data whose reliability can be assessed. Each participating laboratory, or data center, periodically publishes reviews of its evaluations. Tables of critically evaluated data which can be used with confidence are now available for heats of formation of compounds, for diffusion in solids, and for x-ray diffraction in some

30,000 kinds of crystals. We believe this to be a most important program which we hope can ultimately become truly international in participation.

An important measure of a country's technology is its ability to exploit materials. This means that people who are working with materials must have adequate measurement methods for their properties. We have a very large program at NBS concerned with materials science, materials measurements and their application. We are concerned with the development of such measurement methods as electron-microprobe analysis and quantitative metallography, with methods for polymer purification and for trace characterization, and finally, with standard reference materials. A standard reference material is a material whose properties have been carefully measured and so are particularly well known and which can then be used to calibrate a measurement procedure. We issue over 500 such standard reference materials, ranging from ultra-pure aluminum with an electrical resistivity of 0.1473×10^{-9} ohm-cm to D-glucose of 99.9% purity.

The services that I have been describing so far cut across lines of technology. They serve all scientists in the conduct of their work. Perhaps more than half of the work of NBS is devoted to the solution of particular, albeit broad, problems which are felt by entire industrial segments or are national in scope. This work deals much more directly with assisting the country in applying its scientific and technical skills to the solution of major problems. Let me repeat, the ability of a country to utilize and exploit materials is an indicator of the sophistication of that country's technology. This leads to using materials occasionally at the limit of their useful properties and makes for a series of problems that must be of public concern. Many of these have to do with safety. Corrosion, for instance, is probably the major factor in the failure of stationary metal structures such as bridges, underground gas lines (which have exploded with disastrous consequences in terms of property damage and loss of life), pressure vessels, boilers and containers used for shipping liquified gases and other products under high pressures. The corrosion of materials is a very important factor determining their safe use. Metal fatigue is the principal factor involved in the safe use of metals and alloys in rotating or vibrating pieces of equipment. It is often responsible for failures of aircraft and other transportation equipment.

In the tragic collapse of the Silver River Bridge over the Ohio River several years ago, NBS experts were called in to see if they could figure out what might have caused the bridge to collapse almost instantaneously and without warning. As a result of a rather extended investigation, a good bit of scientific detective work, it was determined that corrosion led to the sudden rupture of one eye-bar of the bridge, which caused the entire structure to collapse. The particular phenomenon involved is referred to as stress corrosion cracking.

We work on measurement problems which are important in dealing with the various pollution problems that the country faces today. One can do very little effectively about pollution if one does not have adequate capability to measure the pollutant; that is, to determine what the pollutant actually is, the level at which it is present, and the levels that can be tolerated by the public. Without measurements, one has no basis for determining whether or not abatement procedures that have been undertaken are effective. Recognizing the validity of this viewpoint, we have programs that deal with the measurement problems in air pollution, in particular, the measurement of particulate matter, and the concentration of sulfur dioxide, carbon monoxide, and nitrogen oxides. These contaminants are important contributors to air pollution.

We are studying the chemical reactions in the atmosphere that result in the formation of particular pollutants. We are learning how to use the computer to model entire measurement systems. For example, if one has a limited number of places in a city in which he can put sensing equipment, what is the optimum location of those sensors in order to tell what you need to know about average pollutant levels, sources of pollution, etc.

We recognize today another pollutant, at least in the USA. This is noise. People are being subjected to much higher noise levels today than in the past. This problem is becoming a matter of government concern. We already have laws which set standards for the maximum noise levels that workers should have to tolerate in industrial environments. There is the possibility that we may have federal legislation which will set limits on the noisiness of products that can be sold in interstate commerce. Noisiness is a subjective measurement. It involves more than simply the measurement of physical sound. It is an area in which psychological factors are very important. We are developing a psychophysics program to help us with this and other measurements in which human factors are important.

One of the major national problems today is providing adequate housing for our people. Our building industry produces only about two-thirds of the housing units that are required each year to keep up with our growing population and with the aging inventory of our housing. An important set of problems connected with housing deal with building codes and building standards. The problem breaks down into two parts. At this point in my talk, I will just direct attention to the technical content of these documents. Most of our building codes and standards tend to be design- or specification-oriented--identifying the particular material or the particular kind of construction techniques that can be permitted. Instead there is a need to alter their nature so that there is more emphasis on performance rather than on design. Instead of specifying that a wall needs to be constructed in a particular way--which may have been appropriate 20 years ago, but today inhibits the introduction of new techniques--it would be far better if the code or standard were framed in terms of performance which state what it is that a wall should do: how much of a structural load it should be able to withstand and what its thermal and acoustic transmission properties should be. Accordingly, we have a major laboratory research effort concerned with providing an adequate technical basis for putting building codes into the performance mode rather than the design mode. This means identifying the criteria that are important if one wants to specify performance, identifying appropriate test methodology with respect to each of these criteria, and trying to identify acceptable levels of performance with respect to each of these criteria. We do this in cooperation with the U.S. Department of Housing and Urban Development which has the principal mission responsibility within the Federal Government for providing adequate housing for our people.

I have omitted at this time a discussion of an institutional problem with respect to building codes. Building codes are administered in many thousands of jurisdictions in the USA, and they differ sufficiently from region to region and from locality to locality to inhibit effectively the development of a market which is large enough to encourage capital investments needed for industrialization of our housing industry. This is a related part of the problem. Later I will describe another NBS program which deals with that.

Computer technology is a field in which the government and the public have a very large stake. We have a varied program dealing with computer technology. The Government is the largest single purchaser and user of automatic data processing in the USA. The main direction of the NBS program now, as a result of legislation, is seeing to it that the Government's use of automatic processing is as effective and as efficient as it can be. This involves the development of standards for both hardware and software, the operation of a computer center, offering consulting services for and performing applications research on the government use of automatic data processing. Also, we are beginning to apply the computer to automate some of the experiments in our own laboratories.

Dr. Branscomb mentioned our work on the application of systems analysis and management sciences through our Technical Analysis Division. An illustrative problem was undertaken for a group of city managers having to do with the optimum location of firehouses in East Lansing, Michigan. The computer model used has had broad applicability to many related problems on the provision of public services involving transportation and distribution.

We are concerned with programs dealing directly with public safety--the flammability of fabrics, for example. This is one of our safety-related activities, which include also a broad program of fire research and safety, and the provision of support to other agencies of government that have mission responsibilities in the safety area, but whose managements require the technical support of our specialized skills.

Promoting confidence in the marketplace is the objective of such programs as the training of weights and measures officials at state and local levels, the development of voluntary engineering standards in the private sector, and assistance in the development of performance standards for a variety of products. NBS scientists serve on more than a thousand committees in the private sector that develop standards for articles of commerce. We have a full set of services that are designed to transfer the knowledge that NBS produces to all who can benefit by it. These include an active program of publications, sponsorship of meetings and symposia, and operation of information centers in specific fields in which we have special expertise.

Now, I would like to conclude by talking about a set of activities that deal with strengthening these institutions in the country through which the results of our work are put to use. They may be in the private sector or involve other levels of government. Dr. Branscomb mentioned earlier that the NBS has a statutory responsibility for setting national standards for measurement--mass, length, volume, etc.--but that the enforcement of weights and measures is a state and local responsibility. How, then, does one couple the national responsibility with the local responsibility? In 1905, the NBS found a way to do this which has turned out to be a model that we are using in other areas. At that time we created a National Conference on Weights and Measures which consisted of people from various levels of government and related industry concerned with weights and measures administration. This Conference has met some fifty times since 1905 and provides a mechanism through which we are made aware of the technical problems that the enforcers of weights and measures have in their day-to-day operations. We apply our resources in trying to solve these problems. Our solutions are communicated back to them through the mechanism of the Conference. The Conference sessions also serve to bring about increased uniformity in the development of state and local weights and measures regulations. It has been successful to the extent that weights and measures regulation is no longer regarded as an important impediment to interstate commerce in the United States, as it was at the time that the NBS was established.

A similar mechanism has recently been set up with the states to bring about the uniformity or the compatibility which is so necessary in connection with building codes. We have created with the assistance of the states a National Conference of States on Building Codes and Standards which has representation from all of our states and many local communities. Through this Conference, we expect to obtain knowledge of the specific problems that building code officials have. This will guide our research. This Conference is also a mechanism for transmitting our experiences and knowledge back to them. Most importantly, it serves to improve the uniformity and compatibility of building codes.

There is a concern now that we have no national capability for accrediting laboratories which test products and materials. This is particularly important in the building industry. If we are successful in going to performance-based building codes, local building inspectors will need to have assurance that a new product does, indeed, perform as a manufacturer says it performs and does, indeed, meet the requirements in a performance code. This means that the manufacturer needs to be able to take his product to a laboratory, have it evaluated with respect to a performance standard or performance code, and have it certified that his product meets the code. There must be some system for providing confidence in the ability of laboratories to make these evaluations. We are working with a variety of organizations in the private sector and in the government that are faced with this problem. We hope to establish a voluntary system that will meet a variety of laboratory accreditation needs.

I hope that I have been able to convey to you the breadth of technical services that NBS provides to the USA and the range of sophistication of these services. I hope that this discussion will provide a useful basis for the discussions during the rest of this Seminar.

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Discussion

Co-chairmen: Jorge A. Sabato and Glenn E. Schweitzer

Dr. Sabato:

The fundamental differences between an underdeveloped country and a developed country have been put under discussion. Generally it is said that the difference between one and the other type of countries is related to economic parameters--the gross national product or the distribution of income. A more important difference lies in the cultural problem of how to attain some good for the country. In an underdeveloped country you jump stages--you impose by force, by decree, by law, by all kinds of legal procedures something that would be a benefit to your country. For standards and measurements, we set up institutions with all the power of the law behind them and then superpose these over the culture of the country. This is a general tendency.

I was struck by the fact that the speakers from the NBS repeated several times that NBS has no power whatsoever to enforce its results or methods. Its success then is based on the respect that the community has for its work. I would like to know what happened in the beginning, in 1905, in 1908, in 1912, when the NBS tried to educate people in those states that were underdeveloped in those days in the USA. When Dr. Perkinson read that wonderful quotation I said to my colleague that that was the best description of Yankee domination that I ever heard in my life. Now, what happened when the NBS was created by Congress and began to develop and try to be useful to all the country? I would like to hear the story of the best failure and the best success of the NBS when it was only beginning to be respected. This would be really illuminating for us. Is there an NBS old-timer here that can tell the truth about the early days?

Dr. Condon:

I guess I am the oldest living old-timer, but it makes it extra difficult for me when you add that part about "who can tell the truth." I am very happy that you asked this question because I have just come from a UNIDO meeting in Vienna. That meeting was more narrowly conceived, to cover just the transfer of industrial information, but it is part of our interest here. We must not make the error of thinking that in any of these problems we are dealing with a static situation. You might say that modern industry started in Western Europe. In that sense, the USA, the Soviet Union, and Japan are recently developed countries. Back in the period of time that you are citing there was not much scientifically based industry in America. Let us remember how recent the American developments are. The analogous developments in Russia are even more recent.

The acceptance of the NBS in the USA in that period, and I say it in all seriousness, was the result of the NBS practice of, shall we say, growing the people that would accept it. Prior to about 1910, the General Electric Company and the Dupont Company were the only industrial research organizations in America with any appreciable numbers of people. Some other companies had a few people assigned to research (Corning Glass Works hired its first director of research in 1908). The kind of thing we are talking about is recent. Nevertheless, I think it is also worth stressing that the kind of change we are talking about--taking a country with a very low level of technical development and bringing it up to the forefront of progress--is not going to happen overnight.

It is a fact, I think, that a great many universities in the less developed countries are not very much tied in with the industrial development of those countries. They represent citadels of the old classical kinds of education rather than active representatives of modern industrial technology. Therefore, there is a tendency not to make as much use of them for technology. I encountered that kind of a tendency in the discussions in Vienna from which I have just come, but of course that is part of the problem. If universities cannot be made to contribute to the technical aspects of their countries' development, then we need to change them.

Dr. Sabato:

What do you consider to be the best success of the NBS and the best failure?

Dr. Condon:

The best failure--that is real Latin diplomacy! Lew (addressing Dr. Branscomb), can you help out with the failure? I do not know of any failures. It depends on what is meant. Scientific or technical failures as far as I know are lacking. NBS work has been very good work always. On the other hand, we should call it failure when progress sometimes seems to go very very slowly, especially with the transfer into commercial practice.

Dr. Sabato:

I would like to be more precise with my definition of failure. I am not thinking of the scientific and technical work. I am thinking of failure of the social effect of the NBS. Imagine a group of scientists in the NBS in 1908 or 1910 with a nice idea of changing the habits of commerce. Using such and such methods they develop a complete piece of research and outline a wonderful procedure; yet nobody uses it. You wait for 25 years before anybody pays attention to the work. That is my definition of failure, because it is the failure of achieving within reasonable time a social result from your research.

Dr. Condon:

I think that is a very important distinction and Lew is going to answer.

Dr. Branscomb:

Let me try to answer by describing two failures; one which I think we are reversing and the other in which we are still failing. For the first, I will go back to Dr. Kushner's discussion of the building code problem. The NBS has had a Building Technology Division for many decades and has spent several million dollars a year developing methods of measurement for building materials. A great deal of progress was made in the ability to determine quantitatively the fire resistance of roofing materials, for example. The result of all this work, however, was a very elaborate quality grading system which has been written into building codes by 6,000 separate jurisdictions. Several national studies report that this situation now inhibits the development of an industrialized building industry selling to a 200-million-dollar market. We are now undoing that failure by the procedures that Dr. Kushner discussed.

The other failure is a contemporary failure--the Standard Reference Data System. This is an excellent idea which was generated by a White House panel in 1958. It is a good ten years old now and NBS has statutory responsibility for it. We are even spending two million dollars a year. We have a network of information centers, but there is still no widespread appreciation in the scientific community, or yet in the user community, of the importance or even the appropriateness of quality control in scientific research leading to the development of knowledge about properties. The inconsistent values of the specific heats of copper is a good example. That is still happening. Most of the quantitative information in the basic scientific literature is still not objectively evaluated by experts, and not really usable by an engineer without going through a prototype scale model first to test out whether what the scientist has told is the truth. I think that is a good example.

Dr. Condon:

I think it is, but it also supports what I was saying about the whole game being slow. He is calling the Standard Data System a failure when it has been in existence for only ten years. It is going to take two or three decades.

Dr. Branscomb:

Let me next describe a sort of a success which did not have adequate follow-through; it goes back to your original question about the history. Herbert Hoover was an excellent Secretary of Commerce. He was an engineer. When he became Secretary, about 1920, he appreciated that there was a great deal of chaos in industry, much of it of a technological origin. He established a major program to reduce waste in American industry, and his procedure for doing that was to establish a voluntary system of industrial standardization. The NBS was very much his right arm in starting the institutional structure within the USA for dealing with industrial standardization. In subsequent decades the problem was handed over to industry, but a number of problems developed which now again urgently call for the same kind of government leadership. I think it was the combination of the technical capabilities that the NBS had built up over 20 years, plus the leadership of a major government executive, who himself had an engineering background, that provided the biggest impetus in generating our credibility and effectiveness on the industrial side.

Dr. Schweitzer:

I would like to direct my question to Dr. Branscomb or Dr. Kushner, and I refer only to the physical measurement objective of the NBS and not the national problems objective. Dr. Kushner mentioned the difficulty in quantifying the economic impact of what the NBS does in this area. My question is, What kind of argument do you use in defending your budget before the Congress?

Dr. Branscomb:

I will confess that we sometimes take the easy way out, starting with the premise that the USA is technologically the most advanced nation on earth. We would claim that we have to stay that way and therefore we have to have a capability in basic measurement which is essential for a leadership position. However, the facts of the matter are that this argument both does not work and is not true. As an example, the highest priority item in last year's budget was a major effort to revive a very badly disintegrated capability in applied dimensional metrology. We have in our laboratories the finest capability in the world for interferometric measurements to a precision of one part in 10^{12}, using a stabilized laser which we invented. At the same time, we are not able to keep up with the precision measurement requirements of the modern American. We indeed have a situation in which our optical industry is producing glass scales, intended for use in precision measuring machinery, which we cannot measure with an accuracy comparable to the precision with which they are made.

Many segments of our machine tool industry are moving swiftly to take advantage of these new technological developments. Unfortunately we lack, at the present time, the ability to furnish the needed transfer from the 1:10^{12} technology of the primary standard to the microinch needs of the automated machine industry. We have not until now been pressed because many machine tool users have not been fully aware of the impact of this new revolution on their metrology laboratories. Finally, we appreciated what was happening and we are now taking the leadership in developing measurement methods to match the challenge of the new machine tools. Even so, I am not sure that NBS generation of the capability to respond to what the industry ought to be asking us to do is sufficient, if they do not themselves ask. Therefore we will have to find a way to bring to the attention of the industry the opportunities that are there and I suppose we will do that through conferences, discussions, and encouragement of the leading groups. That particular situation can go either of two ways. We could be successful in bringing this industrial sector along to take advantage of the measurement capability that we know can be generated, even though we do not have it and they do not have it. Alternatively, we could watch what will happen otherwise. Perhaps IBM, or TRW, or some other electronics, computer, or space-related companies will move into the numerically controlled machine area. They might then generate a totally new industry to replace one which will slowly lose out to overseas competition.

Dr. Sabato:

I thank you very much for your example. That is a perfect case of having an overdeveloped science and an underdeveloped industry in the same environment; this is typical in many less developed countries where you have the capability to do many things, but you do not have even the question coming from industry. I think we would appreciate it very much if after some years' time you would publish something about your further experience. In our case we have found that it is a problem of re-educating industry--not only managers, but technicians. In your case of the machine tools, I suppose your industry was importing the measuring element from Switzerland, the real empire for precision mechanical measurements during the last fifty years. How are you going to reconvert your industry? This would be a fascinating experience for us to study in our country where we must try to join two worlds, that of some knowledge and that of an industry which is behind, and many times does not know what kind of questions must be put.

Dr. Work:

I want to speak about the time when the NBS began to be recognized. In the early 20's when I was in college, P. H. Bates of the NBS was recognized as the leading authority on portland cement. When I graduated I took a job electroplating on aluminum for the Aluminum Company of America. At that time, William Blum was still alive and unquestionably the top man in electroplating in the USA. Then the work on the heat treatment of aluminum by Merick, Waltenberg, and Scott was really an outstanding piece of work which is still referred to. All this work on materials was done at NBS in the 20's, and shows that NBS had established a very strong position at that time.

Now, I would like to say a word or two about this question of your doing basic research so that you can understand things and then going ahead to build your industrial economy. I would be curious to know whether anybody here knows of a single example where basic research in one of the less developed countries resulted in the development of an industry. I think that the pattern is actually the other way around. I think that the people who started the radio business in Japan had practically no technical background. A lot of the Japanese production then was quite inferior. They got into all kinds of trouble and then they put in standardization.

This pattern is basically that being followed in Iran where I have just finished a tour as Chief Advisor to the Institute of Standards and Industrial Research. Iran records a very fine increase in GNP. They start an industry based on world knowledge at the time, then they get in trouble when they try to run it, and so they get standards worked in. Iran started a standards institute ten years ago with seven engineers in it. Today it has somewhere around a thousand people. A great deal of the early standards work was on agricultural products, not on manufactured goods. The automobile industry of Iran is now growing very rapidly. The pressures are great to increase the standardization. The next step that will come along arises from the fact that some of the standards problems become so difficult and long-term that you cannot conveniently do them in a quality control organization. So you pull them out and call them research.

It is my impression that if you carefully analyze the growth of research in the USA you would find that a tremendous amount of that growth consisted merely of taking quality control people on the longer term projects and moving them into a separate building which was then called research. In other words, the change was in name more than in activity, and I would like to give you one example of that. I worked for a steel company with a thousand people in their quality control group. There were five people in research, and I was made manager of research and development over these five people. One of the problems on which they were working was why some transmission towers had fallen down. If you threw the component plates on the ground on a cold winter day they would break like glass. Now that would have been a wonderful problem for basic research, but it happened to be applied research because the motivation was to find out just what it was that was giving the trouble. The answer turned out to be nitrogen, and very small amounts of nitrogen--hundredths of one percent.

It seems to me that the story in the USA has been that you first grew your big industry and then you brought your technology and your science in afterward. Japan followed the same pattern in this; they are still being criticized for not having done enough in science. It is my impression that the countries that go at it from the scientific end are likely to have more trouble than those that build up industry.

Dr. Kushner (after comments on the application of basic metrology):

There is not much point in developing metrological skills in a central laboratory if the people who are expected to use these skills and techniques are not also developing at the same time. I think I would like to make a point which I am sure everybody appreciates, but which needs to be stated explicitly; namely that the purpose of the discussion is really to find ways to convert science and technology into economic development. What we are really concerned about is the exploitation of science and technology rather than the state of science and technology itself. In the instance of Japan, that Harold Work mentioned, economic development has been based on existing technology, developed elsewhere. The particular skill that the Japanese people brought to it was their sense of organization, the financial arrangements, and the assistance of government in an economic and policy sense. These made possible the development of an industry based on technology that was available to anybody. Moreover, I think that one must not lose sight of the fact that industrial and economic development relates to the state of a country's science and technology only through a host of other policies and institutions which must be taken into account. Japan clearly provided these systems.

Dr. Perkinson:

The key to everything that has been said here so far in this discussion is organization in the scientific and technological areas and in their industrial applications. It is the entire system you have to be concerned with and this is where the real problem lies. It is not a matter of which comes first and which second so much as how they work together. How do you organize things so you really produce the results which you are looking for?

Mr. Peiser:

I am coming back to our chairman's request to be told about an NBS failure. I would like to talk not about one failure but about a whole group of failures because I believe these are relevant. I also refer to Mr. Bernstein's remarks earlier today, that we must treat this Seminar as looking at a real world where AID and other organizations concerned with assistance to development have to think very clearly about priorities among competitive needs. There is more to do than AID can hope to do. NBS faces this situation in different areas. In measurement, there is a lot of good and important scientific work to be done, much more than the NBS can tackle. Our management has to make hard choices, very often not between good and bad programs, but among several good programs. It is our wish to offer whatever support we can give to AID and other organizations that look to providing the type of services for less developed countries that we provide for USA. We would love to help and encourage organizations in other countries where this is desired, but we have to realize that within NBS we are in competition for limited resources. We live in a real world where NBS is experiencing a failure to do all that this country really requires of its organization. In this Seminar therefore, we must focus on priorities and on the optimum techniques of dissemination that NBS should attempt to use.

SESSION 2 - THE SOCIOLOGICAL, ECONOMIC, AND MANAGERIAL ENVIRONMENT IN INDUSTRIALIZING COUNTRIES

Paper 2.1 - Overview - The Anatomy of an Industrializing Economy

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The task of outlining briefly a broad frame of reference concerning the characteristics of an industrializing economy, with particular relevance to the application of NBS capabilities, involves a considerable degree of selectivity. I have chosen to concentrate not merely on the structure or "anatomy" of such an economy but also on certain aspects of its functioning and processes as well, drawing attention particularly to the constraints and problems for industrialization.

It is obvious that an attempt to provide an overview of an industrializing economy involves much oversimplification. There is a broad spectrum ranging from countries at the earliest stages of industrial development such as Afghanistan or various countries of Africa, to those with industrial structures of considerable complexity such as Brazil, India, South Korea, Mexico, or Taiwan. There are, of course, important differences among countries within such a broad range, but there is a thread of common characteristics, with which I propose to deal, that sets the "industrializing economy" off from the "industrialized" or "developed" economies of most of Western Europe, the United States, Canada, Australia, or Japan.

1. The Rationale for Manufacturing

During the last several decades the less developed countries--or LDC's for short--generally have seized on manufacturing as a way of breaking out of economic stagnation. There have been various immediate reasons from time to time, such as the sharp decline of foreign exchange earnings during the depression of the 1930's and the supply shortages during World War II, but the fundamental factor has been the difficulty of achieving acceptable rates of growth in economies dependent mostly on the export of primary products. Industrialization, usually by the route of import substitution, has been looked to as the engine of economic progress. Furthermore, it has been perceived that most of the rich countries have highly developed manufacturing sectors, and the development of manufacturing has therefore been equated with the attainment of high levels of living standards.

Increasing amounts of foreign exchange are needed by industrializing economies to support the requirements of development. In this connection, industrialization has been looked to as a means of releasing foreign exchange, through savings from the replacement of manufactured imports by domestic production. Furthermore, the demand for most of the primary products which constitute the bulk of exports from the LDC's does not increase at a rate high enough to meet foreign exchange requirements. An adequate expansion of export earnings is felt to be possible only through the export of manufactures, including those involving a greater degree of processing of those primary products traditionally exported in a crude state. Industrialization is thus looked to as a means of alleviating in various ways the endemic problem in LDC's of foreign exchange shortages.

Industrialization is also relied upon to alleviate the problems of underemployment and unemployment. Underemployment, or the utilization of manpower below its potentials, is of course merely another way of expressing a lack of development and low income and living standards. When dealt with through increasing productivity in agriculture--not quite so easily achieved as in manufacturing but perhaps of even greater importance considering that the rural sector is the predominant one in LDC's--another problem is aggravated: the drift into urban unemployment. Industrialization is the principal alternative to agriculture for raising national levels of productivity, i.e., of reducing underemployment, and it is also expected to provide the stimulus, directly or indirectly, for mopping up increases in the idle labor force in the cities.

Finally, industrialization is supposed to give rise to a self-generating process of development. New skills are created in the industrialization process, and demands are passed on for expansion of other sectors of the economy, because of linkages in the production process and the greater purchasing power of the more productive industrial workers. In other words, industrialization is looked upon as the most dynamic element in total economic growth since it is a process which induces expansionist changes in the structure of the entire economy.

2. Industrialization Policies and Some Effects

As indicated, most LDC's have pursued industrialization policies aimed at import substitution, i.e., industrialization with an "inward" orientation. They have as a rule felt that the development of manufacturing for well-known domestic markets, protected against outside competition, is easier than manufacturing for the much more exacting conditions of international competition. Such policies, however, have certain marked shortcomings, and in recent years among LDC's there has been a growing realization of these shortcomings.

The typical pattern has been to start with import substitution in the consumer goods field, first in non-durables and later in durables. Once the import substitution process for consumer goods comes to full effectiveness, the logical extension is into intermediates and capital goods. At the latter stage the undesirable effects of import substitution policies tend to be compounded. Economies of scale are generally more important in the more complex manufacturing of intermediates and capital goods, and the cost differentials compared with highly developed countries are therefore greater. Furthermore, the higher costs and prices of locally manufactured intermediates and capital goods have a pyramiding effect on the entire domestic cost-price structure since they are inputs for other industries.

The policies applied to carry out this strategy have included import tariffs or direct quantitative control of imports, coupled with the local maintenance of exchange rates which are not depreciated enough to lead by themselves to an equilibrium between exchange earnings and expenditures. Such "overvalued" exchange rates are maintained for various reasons--among others, as a matter of national prestige, and to keep the cost of imports from rising, particularly imports of foodstuffs, raw materials, and those capital goods and intermediates which are not domestically produced.

There are various undesirable results which have ensued in many LDC's from this approach to industrialization. Manufactured goods tend to be high-priced and cannot compete in international markets. Foreign exchange savings from import substitution are offset by import requirements of equipment and intermediates to keep factories going, and the demands for consumer goods (including perhaps expendable ones) may rise because of their very local production. The balance of payments situation may therefore turn out to be even more vulnerable than before the process of import substitution was undertaken.

Undue benefits to manufacturing tend to have an adverse effect on agriculture. Inputs for agriculture and consumer goods purchased by the farmers rise in price, diminishing in turn the purchasing power of most of the population for the output of manufacturing. Furthermore, investment and productivity increases in agriculture are discouraged, and the agricultural input requirements of manufacturing are adversely affected. Frequently problems of food supply are created, requiring unduly high food imports.

The effect of industrialization in increasing employment has also been limited. With overvalued exchange rates, the imported capital goods are relatively cheap, and capital-intensive rather than labor-intensive investments are encouraged. Capital-intensiveness in industry is furthermore frequently induced by preferentially low domestic interest rates to encourage industrial investment. In any case modern industrial techniques, being transferred from industrialized countries where they are developed with a labor-saving motivation, inherently work against an LDC taking advantage of the abundant availability of labor relative to capital. The employment effects of industrialization depend to a considerable extent on the indirect demands for labor induced in the services sector. But the success of such induced effects depends on the momentum generated in the industrialization effort itself, which tends to be limited under the type of import substitution process outlined.

3. Role of Manufacturing in LDC's

Manufacturing in the LDC's taken as a whole represents perhaps 20 to 25 percent of the total output of goods in these countries, compared to 60 to 65 percent in industrialized countries. Manufacturing output in the LDC's is equal to little more than half the agricultural output, whereas manufacturing output in the industrialized countries is more than four times as much as agricultural output. Manufacturing has nevertheless been the most dynamic sector in most LDC's. In recent years growth rates in manufacturing, averaging perhaps 7 percent per year, have been about 40 percent higher than growth rates of total output in all sectors. Manufacturing growth rates in LDC's have been about triple those in agriculture. Such high growth rates may perhaps continue in some LDC's at lower stages of industrial development pursuing policies of import substitution, but there is a real question as to whether they can continue for many countries in the advanced stages. Many of these countries are fast approaching the end of the relatively easy phase of import substitution. Further growth is dependent on more import substitution, in lines where difficulties and cost differentials are greater; on the growth of domestic demand, which is generally slow; and on exports beset by competitive difficulties for both internal and external reasons. This is, of course, not to say that the picture is uniformly bleak. There are examples of considerably greater dynamism in a number of LDC's particularly small countries that have pursued industrialization policies with an eye toward foreign markets (Korea, Singapore, Taiwan), and in selected lines of industrial activity in some other larger LDC's (a variety of capital goods in India, machine tools in Brazil, small transformers in Mexico).

Industrialization in the LDC's needs special inducements because of the disadvantages in their environment relative to that of the highly developed countries. Manufacturing in the LDC's cannot be expected, at least in the early stages, to compete internationally under conditions of free trade, and a policy of laissez faire cannot therefore be expected to bring about sufficient industrial growth. The fundamental problem is to design policies aimed at overcoming the disadvantages in such a way that the policies will contribute to achieving the objectives of industrialization; or else the process will be self-defeating. Industrialization is a means to an end--not an end in itself. The basic objectives, as previously noted, are the attainment of increases in productivity and employment and of a process of self-propelled growth, within the framework of an equilibrated balance of international payments.

It is instructive for our purpose to cite some of the disadvantages for manufacturing in the environment of the LDC's.

(1) Many of the LDC national markets are small in absolute terms, and even in countries of larger populations, there is inadequate purchasing power for manufactured goods. Economies of scale, which are widely characteristic of manufacturing operations, are therefore difficult to achieve.

(2) Manufacturing requires entrepreneurship, organization and management ability, and an educated labor force. These elements evolve and are reinforced by the manufacturing process itself, but they are in seriously short supply where manufacturing is either absent or is only in its early stages.

(3) Manufacturing also requires physical infrastructure facilities, such as transport and power. While great strides have been made in this respect during the last several decades, LDC's are obviously still at a considerable disadvantage relative to the industrialized countries.

(4) Manufacturing also requires cheap and dependable supplies of materials and component parts. Factories cannot easily prosper on a sound basis on their own; a widespread network of ancillary industries is required to supply the inputs. If they are not available, difficulties inevitably arise because of shortages of foreign exchange, because of the need to maintain high inventories, or because of delays and imbalances in production runs.

(5) Manufacturing also requires a pool of savings available for investment. Aside from the low level of savings in LDC's, resulting from the very fact of their underdevelopment, institutions for the effective mobilization of such savings as do exist are themselves underdeveloped.

Poor public administration and government services may be added to this catalogue of handicaps. In view of the need for official encouragement of manufacturing in LDC's, it is inevitable that there will be a greater involvement with government administration than in developed countries, and this greater involvement must occur precisely in an environment where civil service standards leave much to be desired. The same somewhat paradoxical set of circumstances prevails with respect to government services, e.g., in standardization--the needs are great, while the capacity to meet them is small.

4. External Assistance for Industrialization

In certain ways the less developed countries rely on external assistance for industrialization to an even greater extent than for their economic development requirements as a whole. From the purely financial point of view, external savings account for perhaps double the share of total investments in manufacturing in such countries, compared to their share of investments in all sectors taken together, perhaps 30 percent in manufacturing investments as against 15 percent in all sectors. Foreign financial assistance for manufacturing comes about half from private sources and half from public sources. The private share mostly takes the form of foreign direct investments in manufacturing enterprises and export credits to finance the export of manufacturing equipment. The attitudes in less developed countries toward foreign direct investments in manufacturing are much less hostile than toward foreign investments in other sectors, such as extractive industries and public utilities. The recent nationalizations in some Latin American countries and elsewhere have been generally in mineral industries; the bitter historical conflicts in Mexico over the expropriations in petroleum and nationalizations in public utilities have not impeded a heavy flow of private foreign investments into manufacturing. The private foreign investments in manufacturing are increasingly taking the form of partnership arrangements, with interests from within the host countries. Export credits, generally easy to obtain because of the coincidence of interest by the LDC's with that of the industrialized countries which want export sales, are frequently subject to excessive use and to abuses of various kinds.

The public share of financial assistance for manufacturing is still dominated by bilateral assistance from donor countries, but the trend is toward an increasing share from multilateral agencies--the World Bank Group as well as the several regional development banks operating in Latin America, Asia, and to some extent in Africa as well. The World Bank Group provides assistance for industry to the extent of about a fifth of its total commitments, now in excess of $2 billion per year; with the more than doubling of its total annual commitments during the last couple of years compared to the preceding five years, its commitments for industry are now close to $500 million per year.

Technical assistance for manufacturing is, of course, associated with the financial assistance. In the private sector, foreign investors bring their technology and know-how with them in very direct fashion. The public sector of financial assistance has less built-in technical assistance, but nevertheless involves technical assistance in one form or another in the execution of projects. Multilateral agency investment is generally very much concerned with the technical assistance requirements. Apart from the financial assistance, there are also public programs of technical assistance per se for manufacturing--both bilateral, as evidenced by this Seminar, and multilateral. Indeed, the very raison d'être of one multilateral agency, the United Nations Industrial Development Organization, is the provision of such technical assistance. In any case, virtually all manufacturing activities in LDC's indirectly involve international technical assistance since the technologies are fundamentally borrowed from the industrialized countries.

5. Conclusion

To recapitulate, there are marked differences between the environment in an industrializing economy and that in which the NBS has evolved. The fundamental challenge consists of adapting the NBS capability to these different circumstances. In considering how this can be done, it seems to me well to bear in mind, among numerous other factors, the following:

(1) There is a considerable variation among LDC's in the levels of industrial development attained.

(2) In almost all LDC's there are islands of considerable industrial sophistication and efficiency in the midst of seas of primitive techniques and inefficiencies.

(3) The industrial technology that tends to be applied in LDC's is that which has been developed for the labor-scarce environment of industrialized countries, with virtually no national or international effort being devoted to exploration of the extent to which technological requirements of LDC's may be unique.

(4) Industrial entrepreneurship in LDC's is to a large extent a personal or family enterprise, with little concern for continuing research and development; for that the enterprise relies on the results of such effort in industrialized countries.

(5) Industrial operations are frequently carried out on a low-volume

high-profit-margin basis, in a protected environment, with little competitive spur to reductions of cost and improvement of efficiency and quality.

(6) Import substitution policies frequently induce production of an excessively broad range of products in individual plants at inadequately low scales of volume.

(7) The development of institutions to provide efficient government services is in need of vast improvement; as improvements proceed, it may be possible concurrently to tap more efficient resources that are available in the private sector.

(8) Finally, on a more positive note, there is a growing realization among policymakers in LDC's of the need for a new orientation of policies to induce expansion of manufacturing along more efficient lines, although the practical problems of dealing with vested-interest inefficiencies should not be underestimated.

I trust that this presentation will have served to demonstrate that the industrial sector in LDC's, for which NBS technical assistance is contemplated, is beset with difficult fundamental problems, and that the answers to the question of how best to organize such assistance are by no means simple.

SESSION 2 - THE SOCIOLOGICAL, ECONOMIC, AND MANAGERIAL ENVIRONMENT IN INDUSTRIALIZING COUNTRIES

Paper 2.2 - A Case Study from Latin America

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In the case story I am going to recount I aim to throw light on some of the key questions of this Seminar, namely, how to couple science with technology, how the experience of an organization such as NBS can be of help to less developed countries, and last, but not least--in view of the interest the problem sparked during the first session--how to relate basic and applied research. However, mine is a personal story. I apologize for that, mainly because personal stories can be extremely boring. Nevertheless, I believe I have a good pretext for choosing this particular one. As you will see, NBS people, without their knowing it, are very much involved in this story, so much so that I consider that the NBS philosophy has been responsible for what proved to be a very important development for Argentina.

The story tells how science and technology were coupled to the development of the process metallurgy branch of Argentine industry, concerned with the manufacture of metallic products. It began in 1950 and has not yet ended, so new developments can be expected in the near future. That you may fully understand this review, let me give you briefly a picture of what has happened in this field in the last 20 years. In 1950, Argentine process metallurgy was in its first stages of development--its light sector (production of consumer goods) was gaining momentum, but its heavy sector was practically nonexistent, with the single exception of the machine tool industry which was shaping up quite well. At the same time, metallurgy as an academic activity was also practically nonexistent, there being no systematic research and development. In fact, there was no possibility of obtaining a degree in metallurgy in Argentina at the time!

In 1971, by contrast, the situation is altogether different. Argentina is now an industrial country (agriculture accounts for only 16% of the gross national product, while industry accounts for 38%, and process metallurgy is one of the more important sectors--30% of the total industrial activity). Argentine industry manufactures not only a complete range of consumer goods (from refrigerators to TV sets), but also automobiles, locomotives, electric transformers, large boilers, heavy chemical engineering equipment, and the like. On the academic side there are about 15 research and development centers, one of which has a staff of approximately 120 scientists and engineers, and a total investment of more than 2 million dollars; one can now obtain a degree in metallurgy from at least 5 universities; metallurgical scientific papers are published at a rate of more than 150 a year; and there exists a very active Argentine Society of Metals that organizes technical meetings and symposia.

In this frame of reference, let us now proceed with the story proper: In 1950 an Argentine company, whose field of activity was the manufacturing of copper and copper alloys (tubes, rods, sheets, wires, and so on), decided to install a chemical and metallurgical laboratory to control the quality of its products. You may think: "A rather trivial and obvious decision", but what was not trivial was that a theoretical physicist without any experience whatsoever in metallurgy was appointed director of that laboratory, and that he was given a wide margin of liberty to organize it, particularly vis-a-vis the production department.

I was that theoretical physicist, and my ignorance regarding metals was really encyclopaedic. I did have some knowledge of wave-functions in metals and so forth; but, as you can well imagine, nothing could be more inconsequential than quantum mechanics when dealing with practical problems of melting and casting, extruding and drawing, rolling and heat-treatment.

My first problem, besides acquiring a little knowledge of process metallurgy, was to choose a strategy for the proposed laboratory. In those days--at least in my country--it was accepted that a factory laboratory was just a production tool, and that, consequently, quality control was more a routine activity than a creative one. Metallography, analytical chemistry, materials testing and the like, were just techniques to be applied with discipline. A little applied research--in practice usually only trouble shooting--was tolerated, but there was not very much in the way of real research and development.

It was then that I read a short story--I do not now remember where--on the National Bureau of Standards. It was a paper of a general nature, describing NBS activities and relating a little of NBS history. At this juncture, an important realization impressed itself upon my mind: NBS was organized to perform routine matters with a philosophy that was not routine. Metrology seems to be a routine job, and is in fact so considered by many institutions all over the world; and, if that were really so, the immediate consequence would be that such institutions can attract only routine minds. This train of thought provides feedback; routine minds can perform only routine activities. However, as we know, NBS attracted very bright minds indeed, and so it not only was able to develop metrology, but it also became one of the most active R and D centers in many fields of industrial development. NBS did all the metrology required by law, but it went much further than that; it helped U. S. industrialization through R and D not directly related to metrology, yet NBS throughout served that function under the cover of metrology. To mention only one of many examples, NBS during the twenties was one of the most important U. S. laboratories in process metallurgy. This example was the direct inspiration for my own case: I decided to organize the laboratory in such a way that it could commit itself to perform the activities necessary to meet all the needs of production, provided the company gave the laboratory complete freedom to plan and perform its R and D program. Following the NBS example, it was our purpose to use quality control as an "umbrella" to foster R and D in the process metallurgy of Cu and Cu alloys. It was, of course, a much broader objective than the company originally had in mind; but we were sure that, if we followed the NBS pattern we would be able not only to satisfy normal quality control needs, but also to achieve many other important results.

Once this strategy was established and accepted by the company's board of directors, two immediate consequences followed:

(a) the laboratory would be fully independent of the production department (it would report directly to the president of the company); and

(b) the senior personnel of the laboratory should have the capability to perform research.

We would try to pick brilliant and creative minds without paying too much attention to whether they had had much previous experience in process metallurgy. Let me give you an understanding of how we selected our personnel. As you are aware, in many laboratories metallography is considered quite routine, and much importance is attached to a man's prior experience. So, in order to select our first man in metallography, we examined more than 25 candidates with previous experience in this discipline. However, as none of them appeared to have a really creative mind, we forgot about previous experience and decided to take on a young man with a Ph.D. in chemistry, who was employed by a large pharmacy where he was in charge of controlling the purity of drugs by chemical analysis. It proved most successful; after a few months' time this man had an excellent command of metallography, and not only organized all the control procedures for our products, but also introduced--for the first time in Argentina--such techniques as electrolytic polishing, texture analysis by means of etch-pits, and so on to techniques which were new elsewhere also.

Again we were just applying NBS philosophy: Always use a bright mind for any responsible work, no matter how routine it may seem, and you will achieve the best results. To put it simply, there is no routine work in R and D, there are only routine minds. If a brilliant man tackles a problem as routine as the measurement of the electrical conductivity of copper, then the electrical conductivity of copper ceases to be a routine problem from the moment our brilliant man begins tackling it.

The laboratory was organized following this strategy, and I am glad to report that it was a complete success. We did all the quality control work that was required by the production department, and at the same time we produced some important developments on our own initiative, not stemming from requirements made by the production department, or for that matter by any other company department. Let me give a few examples, we developed

(i) the process for manufacturing metallic strip for dry-cell cans, which was then being imported either from the U. S. or the U. K.;

(ii) a new method for casting deoxydized copper ingots;

(iii) a new lubricant for wire-drawing; etc.

Apart from that, we published several academic papers in international periodicals (Revue de Métallurgie; Journal of the Institute of Metals), so that the laboratory did work in both applied and basic research.

Now, since this problem of basic against applied research was deemed to be of importance by many of you during the discussions of previous papers, I would like to make a few comments. It is becoming increasingly fashionable to try to decide on the most desirable kind of research, and much time and effort are spent assessing the relative advantages and disadvantages of pure research versus applied research, basic applied versus applied basic, basic inspiration versus applied inspiration, and other equivalent and convenient combinations of similar terms. This exercise unfortunately is not a very useful one; for there are not only the epistemological difficulties of meaningful distinction between one kind of research and another, but also the many surprises which history should lead us to expect. Scores of abstract researches have produced important technical and economic transformations.

As regards epistemological difficulties, allow me to tell you the following short story. A friend of mine works in biology. One day I asked him what kind of work he did in biology, and he answered me proudly: "I am doing basic research." "Oh, I see", I said, "and what kind of basic research are you doing?" "Well, I am studying membrane behavior." "Oh, so you are engaged in applied physical chemistry, are you?" My friend was astonished. The matter does not end there, naturally. If my friend were a physical chemist doing basic research in that area, it would really be in applied thermodynamics; if it were thermodynamics, it would in reality be applied research in epistemology (as Bridgman discovered, by the way). Even this conclusion is not the end yet; pure research in epistemology is applied research in semantics--and if you believe in God, there is still another step. If God is the origin of everything, basic research is concerned with the nature of God, as Pascal realized when he decided that physics and mathematics--fields of knowledge in which he performed work of paramount importance--were not so pure as theology. In consequence, he resolved to do research in theology. You can, of course, take this analysis as you wish. From my own point of view it just goes to show how difficult it is to give a real meaning to the problem of establishing a clear distinction between terms such as basic and applied.

With respect to historical surprises, let me remind you of what happened to Irving Langmuir's work, and its practical consequences. Round about 1910 Langmuir, who was at the time a secondary school teacher, went to work on a very basic piece of research at the then modest laboratory of the General Electric Company. He went there during his summer vacations. For reasons that only he knew, he was interested in the vapor pressure of metals, and at G. E. he had the chance to carry out his experiments. In Langmuir's mind, this was a piece of research without any practical application whatsoever, but as you all know it finally led to the tungsten filament lamp.

There are many similar stories of fundamental or amateur research that has resulted in very practical applications. History seems happy to spring such surprises. Many of you know that at NBS research often begins out of sheer curiosity and ends up in significant development. The secret, of course, lies in the quality of the mind behind that research.

In my opinion, this philosophy was the key to the success of NBS, but you will have observed that many other standards institutions have ignored it, although nominally based on the NBS model. In one of the speeches made this morning, it was said, and very rightly so, that the name of NBS is misleading, because in fact NBS has been, and continues to be, much more than an institution in charge of standards. It is an institution that has not limited itself to dealing with standards, but has espoused the wider objective of industrial development. Countries often copy the NBS name and statutes, but not its philosophy and tradition. In our company we did, and I am glad of this opportunity to express our gratitude for the help we received from NBS without the latter's knowledge.

Before ending my story, I would like to add that our laboratory has helped the company to become one of the most advanced in the field of copper and copper alloy products in Argentina. It was recently able to gain a very important order for many tonnes of copper alloy tubes to be used in the first nuclear power station which is presently being built in Argentina. This order was tendered internationally, and we won in the face of keen competition from foreign bidders.

The final part of my story--which is so personal that I must again apologize to you--deals with how our experience was applied in another Argentine institution, the Argentine Atomic Energy Commission, where we organized the department of metallurgy following the same NBS philosophy. The main objective of that department was to develop a capability in the field of fuel elements for nuclear reactors. We again asked for, and were accorded, complete freedom to organize the laboratory in such a way as to be able not only to work in nuclear metallurgy, but also in all those aspects of process metallurgy that could aid us in fulfilling our task. With this philosophy we were able not only to manufacture all the fuel elements for the four research reactors presently in operation in Argentina, but also to help Argentine industry in many developments, such as the forging of special steels, the rolling of aluminum rods, the development of new alloys for cutting tools, the heat treatment of stainless steels, and so on, comprising no fewer than 250 industrial problems. Furthermore, we have published about 200 academic papers in the most important metallurgical periodicals (Acta Metalurgica, Scripta Metalurgica, Revue de Métallurgie, Journal of the Institute of Metals, Journal of Applied Physics, Journal of Nuclear Materials, Materials Science Journal, etc.).

The organizers of this Seminar have told us that its main purpose was to discover ways and means for NBS to help developing countries, in their efforts to achieve economic and industrial development. My story shows that the best aid we can receive from NBS is a clear understanding of the philosophy that has made possible the tremendous success that NBS itself has registered.

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Paper 2.3 - Labor Saving Versus Capital Saving Industrial Technology for the Developing Countries*

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1. The Range of Technologies

The highland people of West Irian on the island of New Guinea employ stone-age technologies today. Their 1968 model stone axe, for example, is a "capital good" used for the construction of boats, wooden utensils, houses, and the art work adorning the houses. It is also a "consumer durable" as it is used to sever various parts of the human anatomy during the games played in the highlands. The cutting edge of the axe is a versatile tool which when used in a handle of modified design becomes the agricultural digging hoe. The stone-age people who are given the name "Acheulean" also employed a similar tool except for the recent refinements in finish and some changes in styling. Thus for a period of about 200,000 years a major capital good used in manufacturing industry went through very little change.

All of a sudden, culturally speaking, people over the developing world are being confronted with our sophisticated tools. Let me anticipate the objections of the reader by stating that the writer is aware that India, for example, has had a rail and telegraph system for over a century, that Accra has two television assembly factories and that petrochemical complexes are following steel mills as new status symbols in many of the developing countries. But I should like to point out that these examples of sophisticated industrial development are almost exclusively found within or as links between small islands of modernity set in seas of archaic technologies. Only twenty years ago the paper industry of Mainland China consisted of two mechanized mills plus thousands of factories making paper by hand and turning out 300,000 tons a year of a product untouched by metal in any form except for the knife blade that cut the bamboo in the forest. Sugar cane in China was being crushed between two stone rollers meshed by wooden pegs. Even today in India, millions of workers use equipment made solely of wood. The hand textile industry of Ethiopia, producing over half the cloth utilized in the country and employing over 100,000 individuals, not only does not require any metal but has never been introduced to the flying shuttle. The cultures of many areas of the developing world are more appropriate to the stone-age economy than to the age of metals.

2. Development of Labor Saving Technologies

The first manufacturing technologies developed during the early years of the industrial revolution used large numbers of workers drawn from agriculture. As more productive machinery came into use, particularly in the textile industry, there was social unrest as workers became surplus. The

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* Unpublished material used as a basis for the Olin Lectures, Yale University, in October 1969. Presented at the Industrialization Seminar by Mr. Rene Schmied of UNIDO.

growing vitality, however, of the revolution absorbed these workers, and in recent decades in Europe and America there has been a rough balance between the workers available and the workers required to operate industrial tools. During the period of increasing demand for industrial labor this balance has been maintained only by designing new technologies that saved labor. The more productive labor saving technologies made it possible for managers to meet demands for increased wages. Thus a further spiral of new designs to save even more labor was touched off.

The accelerating rate of change can be illustrated by noting the man-days of labor a skilled workman would have to invest were he to purchase his own tools:

For the carpenter in the West Irian highlands - about 5 days.

For the owner - operator of an improved loom in Hunan, China in 1949 - about 100 days.

For the Ghanaian working in the Kaiser aluminium plant at Tema near Accra - about 35,000 days or 140 years at five days a week (and in this case the workmen building the equipment would not be living in Ghana).

The conclusion is not that stone tools are better but that the use of modern tools requires considerable adjustment in the developing world.

In the 1940's when serious attention was first turned to the development of the poorer countries it was assumed by all of us that they would rapidly catch up. The industrial technologies we then employed in the U.S. were believed to be quite appropriate for the newly industrializing countries. Since then the widening economic gap between the industrial and the developing countries has decreased the appropriateness of technologies designed in the former for use in the latter. During the past thirty years the per hour cost, in constant dollars, for a skilled workman has increased about five-fold in the U.S. and in addition the installed cost of a machine, if imported, will be considerably higher. What might have been reasonably appropriate in 1939 for India is most inappropriate in the seventies. As the present trends continue we can predict with some certainty that U.S. technologies in the eighties will be even less appropriate to the needs of India--at least as judged by the desirability of employing labor and saving capital.

The developing countries are chronically short of capital. In 1965 they had average per-capita annual incomes of approximately $160. They were able to invest about 15 percent of this sum in new capital and to maintain old capital investments. Thus they had no more than a total of $24 per capita per year for roads, schools, hospitals, home construction, and, incidentally, factories also. The latter received only 18 percent of the total available for capital investment or $4 per capita. (In addition they received annually about $5 per capita in foreign grants and loans for all purposes.) By contrast the developed countries on the average saved for capital investment 20 percent of a much larger per capita income or about $300 per capita. The U.S. invested more than double this amount.

Technologies are most often characterized by their cost per worker. What we are really interested in is not a low cost per worker but a low capital cost per unit of output and a return on capital that encourages investment in competition with other investment opportunities. Hand-operated cotton-spinning machines may cost very little per worker but the capital cost per unit of output is excessive. The 747 jet has an extremely high cost per worker directly employed but a relatively low cost per ton-mile of product. Thus we might characterize the technologies currently employed in the U.S. as "labor saving" per unit output. They may employ more capital per unit output but they are not intentionally designed to use capital. Similarly, the technologies most appropriate to the developing countries might be termed "capital saving" with an end result in most cases of employing relatively more labor.

3. Application of Labor Saving Technologies

Most of the developing countries became independent in a state of euphoria with respect to industrial planning. Many had sizeable credits inherited from the former colonial powers. India was able to finance most of the First Five Year Plan from sterling credits. President Nkrumah in Ghana started his term with a foreign currency reserve of £ 250 million. The Korean War boomed commodity prices giving windfalls to exporting countries. President Sukarno after mis-investing his country's foreign exchange reserves was able to borrow $2,000 million. It is no wonder that a trend in many countries was firmly established towards the use of the most modern and expensive industrial technologies available.

Other factors have contributed to and strengthened this trend. Equipment salesmen from the industrial countries are desirous of selling the most expensive items which in many cases are more labor saving than the equipment currently in use in the typical factory in their home country. The engineering advice available to the developing countries tends to favor the labor saving machinery. Engineers serving as technical experts from the industrial countries have experience with no other technologies. Engineers from the developing countries are almost invariably either trained abroad or through textbooks concerned only with labor saving technologies. American schools of engineering take justifiable pride in sharing with students from developing countries the latest in American techniques and even employ them in graduate research projects to design still more sophisticated techniques. It is only natural that they should wish to employ their education on their return home.

Governments of the developing countries in their desire to accelerate industrialization often contribute to over-investment in capital equipment. There may be generous tariff concessions on the import of foreign equipment. Imported equipment may be subsidized in relation to domestic equipment through below-market exchange rates. Interest rates may also be subsidized in the desire to accelerate industrial development. Factory managers often consciously select labor saving equipment because they are having difficulty in recruiting and supervising workers. Thus scarce capital may be used as a substitute for improved labor relations and worker training. Engineers who wish to design factories that are more capital saving may find information lacking on the availability of more appropriate technologies.

The above considerations tending to favor labor saving technologies in what are likely to be labor surplus areas are not to be counteracted by a wholesale rejection of the labor saving equipment. The suggestion is rather that a more discriminating approach be made to the selection of technologies. India and Ethiopia offer an interesting contrast in the use of industrial technologies. Ethiopia with a very small national market and a poor transportation system which divides the small market into smaller pockets still has on the average larger industrial establishments than has India. Although the average per capita income in Ethiopia, as far as can be estimated, is significantly lower than for India, the wage rates in Ethiopian factories are on the average almost double those of India. Little concerted effort has been made in India to design or to employ manufacturing industry technologies which make a rational utilization of the capital and labor available. India does not do a particularly good job of saving industrial capital; Ethiopia is even worse, as shown by the tables which follow.

Table I - Factory Industry of All Types

	India	Ethiopia
	1960 data for 39,600 operating enterprises (1)	1966 data for 248 operating enterprises (2)
Average employees per enterprise	90	175
Gross annual output per unit fixed capital	3.1	0.9

Table II - Factory Cotton Textile Industry

	India	Ethiopia
	1960 data (1)	1966 data (2)
Number of operating enterprises	3,690	22
Average employees per enterprise	310	680
Fixed capital per employee	$ 390	$1,750
Gross annual output per unit fixed capital	3.5	1.7

The data of Tables I and II lack strict comparability as the product mixes may be different, information on the profitability of capital and the method for estimating the fixed capital investment were lacking, and worker plus managerial skills in India are higher. Note also the tendency in the less developed countries to load factories with extra workers (tea boys, drivers, various assistants, etc.) which tend to distort, for example, data on fixed capital per employee in relation to similar data from the industrial countries. Even with these limitations there obviously is a different type of technology in use in Ethiopia than in India, a conclusion strongly supported by visits to many establishments in both countries.

Even more interesting are the plans prepared recently by a team of foreign consultants for 11 metal-products factories in Ethiopia. The data of Table III are compared to those of factories already functioning in India.

Table III - Metal Product Factories

	India	Ethiopia
	1960 data for 2150 operating enterprises (1)	1967 data for 11 planned enterprises (2)
Employees per enterprise	44	42 (full capacity)
Fixed capital per employee	$ 570	$5,600
Gross annual output per employee	$2,300	$9,800
Gross annual output per unit fixed capital	4.1	2.1

Accelerating population growth rates are the main reason for growing unemployment but the use of labor saving technologies also contributes. The countries of Asia and Latin America have long had unemployment and under-employment problems. Even in Africa where the man-to-land ratio is much higher, there is increasing unemployment. For India the ratio of manufacturing industry workers, both factory and artisan workers, to the total population decreased between 1901 and 1961 by about five percent. (In the U.S. during a similar period of rapid industrial growth, 1849 to 1899, this ratio increased by almost 20 percent.)

4. Justifying the Use of More Appropriate Technologies

The shortage of capital is one characteristic of the developing countries which justifies the use of more appropriate technologies. There are others which distinguish the less from the more developed countries and require new design factors to be built into capital equipment.

The markets in most of the developing countries demand a smaller scale of operation than in the industrialized countries. Disposable incomes are lower, populations within the economic barriers in many cases are small, widely dispersed, and with greatly differing tastes. Transport and distribution systems are underdeveloped. The result is a need for technologies appropriate to small markets supplied by smaller factories. The technologies designed for large scale operations are most inappropriate for small markets.

Raw material supplies, like markets, have a tendency to be limited, dispersed and uncertain as to regularity of supply and quality. Often a technology designed for high quality raw material and for an exacting market is used to manufacture products from raw materials of indifferent or inconstant quality and for an undemanding, goods-hungry market. The technology is misused. Indeed, in order to make it work at all, it may prove necessary to import raw materials to replace low quality indigenous supplies. According to many industrialists, the quality standards required for the export market make necessary the use of labor saving technologies. The Japanese, however, have been able to export products of which the components, at least, have been manufactured by capital saving technologies.

Fuel and electric power costs in developing countries may be double those in industrial countries and the supply is often uncertain. A technology requiring continuous operation may lose its advantages if a stand-by power plant has to be installed.

The less developed countries are often described as lacking investment opportunities. What is meant is that there are few markets sufficiently large to justify investment in the type and size of plant to which international investors are generally accustomed. But if we had sharper vision, and refined mechanisms for conducting the search, we could find opportunities to supply smaller markets using technologies of a different type. The main argument in favor of labor saving technologies is that large modern plants return such high profits that the spiral of growth can be started much more rapidly in this way than by employing a strategy of smaller and perhaps less profitable industrial establishments. Large plants can return high profits, particularly when serving a large domestic market, exporting, or enjoying a monopoly. However, a large plant at partial capacity, shut down because it cannot obtain managers, or operating inefficiently because of spare parts shortages, is not likely to show a profit.

5. Strategies Using More Appropriate Technologies

A general conclusion for the countries initiating industrial development during the 20th century is that even rapid industrial growth is unlikely to relieve growing unemployment. The two countries which are exceptions to this observation, Japan and Mainland China, have had in the past and are continuing rapid economic growth without major unemployment problems. Both of these countries have cultures so markedly different from the rest of the world that the strategies they have employed are not generally applicable to other developing countries. In addition, Mainland China has developed its own unique form of economic organization. Even so, it may be of value to examine the strategies and industrial technologies employed by them.

The Case of Japan

Japan initiated its industrial revolution, as did many other countries which industrialized after Britain, by importing the technologies required to establish basic industries for iron and steel, shipbuilding, railroad-building support, electric power, etc. While this process continues on into the 20th century the Japanese added another strategy. The first large companies assisted and encouraged the establishment of satellite companies. These companies operating on a smaller scale and paying lower wages used improved technologies to supply components or sub-assemblies to the larger factories. The satellite companies while remaining under private ownership were tied to the larger companies through long-term contracts which gave them management services and financial support. In time these satellite companies surrounded themselves with even smaller companies which often fabricated wholly by hand the more simple components required by the medium-sized companies. The smaller enterprises had low fixed capital investments per unit production and per worker, an average wage scale approximately half that of large companies, and were dispersed among the smaller cities. In this manner the Japanese mobilized manpower at relatively low capital cost. By 1957, the average fixed capital investment per worker for all manufacturing industry in Japan was only $803 as compared to $3566 in the U.S. (3).

During the 1960's a growing shortage of labor in Japan forced the mechanization and modernization of the medium and small-sized factories. (The technologies recently forced on the Japanese smaller enterprises by a shortage of workers are those that many developing countries employ initially at a time of gross underemployment.) The Japanese willingness to innovate in the employment of capital saving technologies and their ability to employ management systems that made such technologies practical has most certainly contributed to the long-sustained, high growth-rate for manufacturing industry.

The Case of Mainland China

In rough outline the strategy imposed by the new Chinese Government in 1949 was one of importing complete factories from the U.S.S.R. to establish basic manufacturing enterprises primarily for iron, steel, chemicals, and transport equipment. Consumer and capital goods, not manufactured by the relatively few large factories, were to be turned out by widely dispersed factories using whatever machinery and equipment that could be made available. In many cases a boot-strap operation took place, in which the industries to manufacture capital goods had to be established along with the enterprises employing the capital goods. This strategy was restated by Prime Minister Chou En-Lai in a report to the National Peoples Congress in 1959 when he called for a "mass campaign to build small enterprises which use light equipment and employ indigenous methods" to be carried out in parallel with a "mass campaign in the big enterprises using heavy equipment and modern methods." (4) In spite of the vicissitudes in Chinese economic growth rates resulting from the "great leap forward" and more recently the "cultural revolution" there appears to have been remarkable growth in the industrial sector with relatively little unemployment. Some information is available from Mainland China indicating the advantages of capital saving manufacturing technologies. The data are, of course, open to some question since the costs given in Table IV are likely to have been "managed" through various controls.

Table IV - Cost Data for Small and Large Enterprises in Heilung Kiang Province, China 1957

	Brick Factory		Farm Implement Factory		Paper Factory	
	Large	Small	Large	Small	Large	Small
Annual Output per Unit of Fixed Capital	0.81	4.8	0.58	3.6	1.6	4.2
Investment Capital (US $) per Million on Bricks or per Ton of Paper per Year	10,500	3,800	-	-	360	100
Fixed Capital Investment per Worker (US $)	1,500	190	4,600	600	6,700	1,600
Output Value (US $) per Worker	1,100	900	2,600	2,300	10,000	7,000
Annual Profit as Percent of Investment	16	63	21	40	33	140
Number of Years to Recover Investment	6	1.5	5	2.5	3	0.7

Note: Large = more than 1,000 workers
Small = about 100 workers

The writer was able to observe at first hand the beginning of what later became this strategy during the years 1947 through 1949, while directing an operation to adapt and to develop manufacturing technologies suitable to the conditions then prevailing in the interior of China. Metal was introduced for the first time into a number of industries, mechanical equipment which could be manufactured locally was designed for the textile and paper industries, and a pilot portland cement plant using a vertical kiln was designed, constructed and operated. The pilot cement plant developed in 1948 had a production of 2 tons a day and employed 43. All of the equipment was manufactured within China. The fixed capital investment including equipment, land and buildings was $33,000 (at 1948 prices). Enjoying a monopoly in the local market, the cement sold at U.S. $32 per ton--not high enough for the enterprise to show a profit at the low rate of production. The production costs for a full scale plant of a similar design with an output of 25-40 tons per day could have come within 10 percent of those from a plant in the same location using a large horizontal kiln. A model of a similar vertical kiln cement plant designed for 25 tons a day from Mainland China was displayed at an industrial fair held in New Dehli in early 1960. The claim was made that 10,000 such plants were by then in operation.

Normally the Chinese display reasonably modern machine tools in trade fairs. However, the same exhibit in New Dehli included machine tools obviously manufactured for local use and not for export. The designs were archaic, the finish abominable and the castings pitted. However, they had utility for manufacturing simple low quality metal products and for use in repair shops.

The following is a sampling of recent news releases on industrial technologies from the London Office of Hsinhua News:

April 30, 1969. "The workers in a machine tool plant in Fukien province have designed and manufactured a multi-purpose machine tool which can perform the jobs of turning, grinding, milling, boring, drilling and slotting." (Some years ago an English engineer designed and suggested the manufacture in the U.K. (5) of a similar multi-purpose machine tool to serve as a lathe, grinder and milling machine in less developed countries.)

May 1, 1969. "In Shantung province workers invested a new process for small nitrogenous fertilizer plants. By 1968 one-third of the nitrogen fertilizer capacity in China was provided by such plants. Eighteen small plants were set up during 1967 and 1968. All of the equipment, it is reported, was manufactured within China."

June 22, 1969. "A design 'guided by Mao Tse Tung thought' has been made for a new 20 horse-power light-weight diesel engine using a cast-iron crankshaft." (In the U.S. during World War II diesel engines were manufactured with a special cast-iron crankshaft.)

6. Introducing More Appropriate Technologies

The need for more appropriate technologies in the developing world has recently been attracting attention. An Indian engineer, a senior manager in a large corporation, wrote recently: "To borrow technologies from abroad and to rely largely on imported equipment, raw materials and, above all, imported ideas, was the way to give a quick spurt to industrialization. The rapid development of industry since Independence bears witness to the value of this short cut. But now the heavy costs of this first stage are also plain--idle machines; whole units dependent on raw materials which are not readily available; expensive precision tools used for cheap standard jobs; industry requiring skills and services which are only available in a few metropolitan areas; and above all, a rise in industrial output and employment too slow for the country's needs." (6)

In a similar sense a Pakistani administrator wrote: "In the last five years about ten times as much money has gone into nuclear research as into other fields of applied research, e.g. to develop an appropriate technology for the production and manufacture of jute, or for the exploration of the large resources of fisheries that Pakistan possesses." (7)

For the past decade the international organizations have been pointing out the need to explore the possibilities of more appropriate technologies. In 1964, the United Nations secretariat proposed that, "The attention of engineers, scientists and technicians should be drawn to the possibilities of selecting capital saving techniques for the core operations of the technologically inflexible industries." (8) Recently the United Nations Industrial Development Organization suggested a new approach:

> "The search for greater technological flexibility, which is stimulated by typical factor proportions in developing countries, need not involve a return to primitive processes of production, to nineteenth century designs of equipment or to hand-operated blast furnaces. Rather, it requires a greater readiness to eschew unquestioned adoption of the most up-to-date and most prestigious capital-intensive and integrated production processes, which have been developed for use in countries where labour is particularly scarce, and to seek out the efficient processes employed in those developed countries where the relative abundance of capital and labour is somewhat closer to the situation in many developing countries." (9)

Some action on these lines has already been taken. By 1968, the private non-profit organization, Volunteers for International Technical Assistance (VITA), had a roster of 6000 volunteers who during the year answered 2100 questions. The volunteers also adapt U.S. technologies and in some cases develop new technologies appropriate to other economies. Recently, another private, non-profit organization was established in London, the Intermediate Technology Development Group Ltd., to focus attention on and to undertake studies leading to the use of more appropriate industrial technologies in the developing countries. In the late fifties an agency of the Government of India assisted by a foreign consultant designed simple machinery which could be produced locally for lens grinding. The new "modern" equipment is now in use in a few dozen lens-grinding factories at approximately half the capital cost of imported equipment. This industry is currently being introduced into Iran by the same foreign consultant.

Other examples can be given of equipment designed to meet the needs of the developing countries. In the mid-fifties the Government of Burma asked for assistance in the selection of equipment to extract the edible oil from by-product rice bran. None of the equipment available from the industrial countries was found suitable. The Union of Burma Applied Research Institute then designed a ten-ton-per-day plant using quite modern but simple technologies and a minimum of imported equipment. By 1958 the first commercial plant was in operation and by 1962 the technology had been exported to India.

In 1961, N.V. Philips established at Utrecht a pilot plant for the manufacture of radios under the economic conditions prevailing in the developing countries. The pilot plant did not reproduce the techniques used by Philips in previous decades but applied modern science and training techniques to design a new plant using a minimum of capital and a maximum of unskilled but trainable labor. A Philips-assisted electronics factory in Accra which the writer visited in 1969 was demonstrating the success of the earlier research.

Two Dow Chemical Company engineers have recently suggested that the capital investment required in small chemical plants can be reduced. Their design strategy starts with the most simple model of the plant, which is modified only with those labor saving additions justified by the economics of production in the country. In reviewing twelve small plants built abroad they found it practical to use more detailed engineering design as a substitute for considerable amounts of capital. (10)

Not all research of this type is successful. The General Engineering Laboratory of the General Electric Company in Schenectady initiated a project in 1962 to design and test new electric power-generating devices suitable for the rural areas of less developed countries. It had been hoped that some of the new technologies developed by NASA could be adopted. The conclusion from the research was that the small diesel or gasoline engine was still the best power-generating device. However, more recent research on small steam power plants may justify a new evaluation.

The attraction of very simple technologies can lead engineers into economic traps. Muscle power is so expensive that in the long run little can be done without mechanical power. "Man power" harnessed to a machine costs about a dollar per kilowatthour when a subsistence wage is paid. Even in areas of high capital costs, small diesel units can produce at about 20 cents per kWh. Over a quarter of a million dollars were invested in the attempt to electrify Indian villages by employing idle bullock power. The increase in the fuel costs for "working" rather than "resting" were more than for the equivalent amount of diesel oil. [The speed increaser cost much more than the equivalent engine.]

In 1964 an exploratory study was carried out at an Indian institution for the manufacture of a simple agricultural implement--a hand operated paddy weeder--by various technologies, with the results presented in Table V. (6)

Table V - Comparison of Four Technologies for the Manufacture of a Hand Operated Paddy Weeder (6)

	Hand Operated Machinery		Power Driven Machinery	
	(Existing artisan shop)	(Improved factory)	(Existing factory)	(Improved factory)
Labor cost per unit	Rs. 3.50*	Rs. 1.95	Rs. 2.50	Rs. 1.70
Material cost per unit	8.50	8.50	8.50	8.50
Overhead per unit	2.00	2.30	4.00	2.80
Total cost per unit less profit	Rs. 14.00	12.75	15.00	13.00
Capital equipment	Rs. 150	7,200	25,000	31,000
Total employees (single shift)	1	32	30	36
Production per month (single shift)	25	1,500	850	1,900
Capital equipment per worker	Rs. 150	225	835	860
Capital equipment per unit product per month	Rs. 6.00	5.00	29.00	16.00

The conclusion was that improved engineering design could significantly reduce the fixed capital requirement per unit product and also the total cost of manufacturing each unit. Significant cost reductions were shown by giving the artisan better hand-operated tools and by converting his shop to a factory. In the calculations hand tools were depreciated at 20 percent per year and machinery at 15 percent. The artisan was assumed to earn Rs. 3.00 per day. Factory wages were: Rs. 4.50 per day for skilled workers in the mechanized factories; Rs. 3.00 per day for skilled workers in the hand-operated shops; Rs. 2.50 and Rs. 2.00 per day for semi-skilled workers and Rs. 1.50 per day for unskilled workers. The managers of the three factory units were each assumed to receive Rs. 400 per month and each manager was assumed to have one assistant at Rs. 250 per month.

Numerous stories could be told of technologies improvised by entrepreneurs over the developing world: of the battery manufacturer in Bogota; the wire screen manufacturer in Waranga; the towel manufacturer in Pekalongan; the wooden sandal manufacturer in Rangoon; the skirt maker in Kinshasa and the cement-plant manager in Padang. Their success, without

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* Rs. 4.76 = U.S. $1.00 at the time of the study.

the benefit of foreign engineering assistance, suggest that more might be done to design better for the developing world.

7. Further Actions Which Could be Taken

Industrial development will be pressing even harder on resources in the future as attempts are made to carry the growth rate above the present low average of 6 percent annually. Further interest in the saving of capital is anticipated. The following are suggestions:

Education of Engineers

Engineers normally are instructed to "design a plant (or an item of the equipment) to save labor by using additional capital as justified by the saving in labor." For less developed countries the instructions might be rewritten as follows: "design to save capital by using additional labor as justified by the saving in capital."

A manufacturer of walking tractors in India, an engineer with a U.S. degree, designed his plant with the assistance of foreign engineers. After being alerted to the desirability of selecting more appropriate machinery, he re-examined the design of the plant and made significant reductions in the capital requirements.

Analyzing the Product and the Plant

Some products can be redesigned so that they can be manufactured by capital saving technologies. Other products can be broken down into components and each examined individually as to the optimum technology to be employed. Many components can be manufactured more cheaply in low-labor-cost areas by using capital saving technologies. Other components may require an imported technology. One can imagine such an analysis leading to an international division of labor in which those components able to absorb large amounts of labor and requiring little capital equipment would be manufactured, for example, in Java. Other components might be manufactured in Japan and the two areas might be linked by air transport. This type of specialization has already started between the U.S. and Japan.

Industrial Research

International companies that sell equipment or use it in their own plants in the less developed countries have a financial interest in supplying more appropriate equipment. A U.S. Government agency could stimulate the export from the U.S. of such equipment either by direct subsidies or tax concessions. The first exporting companies to find new markets would encourage other companies also to redesign their products. The Australian Government since 1967 has been matching the development costs for new export products of all types with grants up to $50,000. (11) Similarly the less developed countries might re-examine the objectives of their industrial research institutes. The tendency persists for the staff members to continue the research they did in a foreign graduate school. They tend to do work on the problems of an industrial country even when living in the environment of a less developed country. One of the objectives of industrial research institutes in the less developed countries should be to design new technologies with built-in capital saving characteristics as well as to substitute labor for capital in existing technologies.

The justification for research on more appropriate industrial technologies will increase as the developing countries spend larger sums for the import of manufacturing equipment. A United Nations estimate places such imports at $7,500 million for 1975 supplemented by $2,500 million of equipment manufactured domestically.

Prototype Commercial Plants

The United Nations Industrial Development Organization is experimenting with a new program which designs, constructs, and finances a limited number of prototype commercial plants. The objective is to prove that technologies entirely new to the country or the region can be viable under local economic and social conditions. Four such projects, all for small or medium-sized plants, are at varying stages of implementation. An expansion of this program will encourage the design and pilot-plant testing of new manufacturing technologies by both public and private research laboratories.

Transmitting Appropriate Technologies

Even if traditional habits in economic planning and investment decision-making were changed and if the research effort of the less developed countries were directed to the saving of capital, we would still have the problem of adequately transmitting information on more appropriate technologies.

The international consultant carries with him his own library supplemented by a link to the home office. This is sufficient for the limited range of technologies in which the engineering company specializes. This is not adequate, though, for the thousands of engineers who have no supporting office in a highly developed country but require instant information on a wide variety of available technologies. They require an international information service for which they and the manufacturers of the equipment covered would be willing to pay a fee. Sponsorship and an initial subsidy might well come from an international organization working with national associations of equipment exporters. Groups from other countries would follow this example in order to maintain their competitive position.

Lessons from Agriculture

Experience, often bitter, has taught those responsible for the growth of agriculture in the developing world that it is better to transmit the science rather than the technology. Soon after World War II the theory was advanced that seeds developed in one part of the world in a given climate would thrive in another part with a similar climate. The seeds did not respond as anticipated. Since then it has been the science of plant breeding which is transmitted, while each area develops its own particular technology. The most spectacular example of the success of this approach is the International Rice Research Institute established at Los Banos in the Philippines through the joint efforts of the Rockefeller and Ford Foundations.

8. Conclusion

The introduction of more appropriate industrial technologies is one of a number of factors influencing the rate of industrial growth. The factors are interrelated and it is likely that a number of them will have to be changed simultaneously before significant growth will result. For example, a better designed technology can increase the return per unit of capital invested, but so can an improvement in the skills of the manager--which can bring about an average increase of as much as 50 percent without any change whatsoever in the technology employed. The contribution of manufacturing to national income in less developed countries is small. After a rapid post-independence spurt, growth in industrial output is slowing down, yet industrialization is now everywhere regarded as essential. The birth of UNIDO is proof of this.

It will require many years to replace the labor saving technologies borrowed from the industrial countries, and now generally used in the developing countries, with more appropriate and newly designed capital saving technologies. A start can be made, however, by introducing without further delay a number of modest innovations of which the following are typical.

Already over the world various manufacturers are giving thought to alternate designs of capital equipment for use in the developing world. These efforts should be given wide publicity so that more individuals in the developing countries will become interested in and purchase such equipment. An international information service which could identify such appropriate technologies would justify an initial subsidy from international funds.

Where pilot-plant tests proved successful for a new capital saving technology there would also be justification for using public funds to construct the first prototype commercial plant in a developing country. The judicious use of funds in this manner could accelerate the initial dissemination and acceptance of new technologies which might be followed later by commercial efforts.

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SESSION 2 - THE SOCIOLOGICAL, ECONOMIC, AND MANAGERIAL ENVIRONMENT IN INDUSTRIALIZING COUNTRIES

Paper 2.4 - The Role of Technology in Politics and Economics

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This subject title taken by itself is quite vast. It narrows down as we see it in the context of the objectives of this Seminar. First, the aspects of technology of greater interest are metrology and standardization. Further, the discussions should be aimed at less developed countries. Even now, when so restricted, the subject is still vast and I will be able to cover only some of those aspects that I rate as the most important.

The process that turns an underdeveloped nation into a developing country requires a change in the economic and political structures. An accelerated economic growth is necessary and generally the "take-off" results from some kind of political revolution. So deep are the changes involved that in normal situations it would be hard for it to take place. Thus the developing country starts its upward travel towards the club of the developed ones, with at least some instability in the political area. This instability in subsequent stages has to be fought all the way.

The relationships between political stabilization and economic growth are quite strong and present characteristics of a feedback system. A nation needs political stabilization to be able to obtain the necessary economic growth; and there is no better support to political stability than a sufficiently rapid economic expansion.

The best characterization of the economic growth of a developing country is the shift of a good part of the efforts and resources available from the primary to the secondary sectors of the economy, the industrial activities, and further on to the tertiary or service sectors. Productivity is a very important factor and here technology comes into play. Econometric theory includes technology as a factor in the production function, as for example in the Cobb-Douglas equations, together with capital, manpower, and natural resources.

Technology can be imported in the form of processes, equipment, and the know-how that has to be taught to the men that will operate them. The transfer of technology poses a delicate political problem. Such a transfer has to be carefully done; the economic benefits to the receiving country should not be nullified by the draft of economic resources in the form of dividends and royalties sent to the technology-exporting nation.

When this transfer of technology is done through the establishment of branches of multinational corporations, an additional sensibility appears. It should be done in such a way as not to involve a loss of independence to the country where they operate. This problem in more critical in the heavy basic industries, such as steel, petroleum, petrochemicals, copper, aluminum, etc. Some multinational corporations have managed to integrate very well their branches into the national life, bringing a real contribution to the growth of the developing country. Others have not had the same success. One way to overcome this problem is to set up a joint venture with native economic groups; this solution to be successful requires that the receiving country has already reached a reasonable degree of development.

Another aspect related to the transfer of technology is that it should develop in the industrializing country the capability of technology self-generation, if it is to produce desirable results in the long range. Technology transfer that does not create this capability limits the development of the country to a rather low stage.

A developing country when industrializing should plan very carefully. It is true that a country starting its industrialization has the advantage, as happened in the reconstruction of industrial areas in Europe destroyed during the last World War, of choosing equipment incorporating the most advanced technology. It need not be bound by the inertia of a vast industrial plant with equipment that is less productive, but may be still in good working condition and in many cases not yet completely depreciated. However, the planners should not simply go ahead and buy the most advanced equipment they can obtain. They should very carefully consider the social, economic, and political environment of the region where the industrialization is to take place; otherwise, the results can fall far short from the expected.

The Brazilian industrialization process offers a good example. We have two quite distinct regions. The Southeast, which is the most developed area in the country, with the highest ratio of skilled manpower, has no social problems. The Northeast has one of the lowest per capita incomes, and most of its manpower is unskilled. Serious social and political problems arise due to a high density of population in a semi-arid land. During the industrialization effort little regard was given to those differences between the two regions. The results were quite distinct. The Southeast showed an economic growth well above expectation. In the Northeast region, on the contrary, the results were not good; after about ten years of implementation, with many new industries in operation, the industrial employment level decreased around ten percent. There the political and social problems remained largely unchanged. To overcome this situation the government has for a few years been increasing heavily the investment in road construction, electrical generation and transmission, irrigation and other infrastructure projects, all with a participation of much manpower.

As a developing country starts its industrialization several problems appear related to standardization. The existing local industries that are supposed to furnish parts to the new industries may not be used to any kind of standardization, either in types, specifications, preferred numbers, level of quality, or tolerances. To make matters worse we find components coming from countries where the standards are not compatible. The problem starts with nuts and bolts and goes all the way up the range. Let me give two examples of the Brazilian industrialization process, which had the big take-off in the mid-fifties. It should be noted that at that time Brazil had already some industry and a national standards organization with some work done, and that the examples quoted come from the area of highest industrialization, S. Paulo.

The first example is the automobile industry. The lack of standardized specifications and the nonexistence of certification created a great problem on the procurement of auto parts. This contributed not only to a slow start and to a lower quality of the final product, but also to an increase of the price of the car. A similar problem occurred with the electronic equipment industry, in both the domestic appliance and the professional sectors. The initial low quality and non-standardization of electronic components manufactured in Brazil forced the equipment industry either to import parts or to compromise with a lower quality product, in both cases to the detriment of the consumer.

The problem was solved by a long and hard interaction between equipment and parts industries. They have reached a compromise situation, but it is by no means ideal. If we had had a national system of reasonable standardization and certification, the development of our industry would have been faster and smoother. The manufactured products would be of a better quality and be priced lower, with advantage to the domestic consumer and with a better chance in the export market.

A protective tariff is a normal political instrument used by nations to support an industrialization process. Although sometimes essential, it can become a dangerous instrument if not applied properly. It can easily become an incentive to a poor industry, with low quality and high prices, rather than a factor producing healthy industrial growth. The fundamental concept in a protective tariff policy is that of "similar products." A correct definition of similar product requires similar specifications on performance and quality, reasonable prices and availability to the consumer in the quantity needed when needed. What constitutes a reasonable price depends much on the importance of the product relative to the economic development of the country. The more essential it is, the larger the differential in price, relative to the imported similar product, that can be accepted. The most important task and at the same time the hardest one is to insure the similarity in specifications and quality between the national product and the imported one. Only an efficient system of standards and certification can guarantee compliance with this aspect of similarity. Without it, the best protective tariff policy fails to produce any positive results. It would then seem advisable that an industrializing country should include in the earlier stages of its development plan, the establishment of a national system of standards with a scheme for certification of compliance. The cost of such systems will be paid back by faster industrial growth toward the desired level of quality. It will also be repaid through the lessened economic burden put on the consumer, be it another industry or a final consumer.

About two years ago a joint U. S.-Brazil group finished a study of the standardization situation in Brazil. The results of this study are being analyzed by the Brazilian authorities. However, it will be useful to discuss its conclusions, because a rather complete review was made of the Brazilian situation and of the experience of several countries with different levels of development, taking into account among other aspects the economic and political environment. It was concluded that all the institutions involved in the maintenance of physical standards, the production of norms, and the certification of compliance, should be organized in a system. Although the institutions should be private, the activities in the system should be coordinated by a federal government officer. The components of the system suggested, illustrated in Figure 1, are:

(a) Systems Coordinator--a high level federal officer ranking just below the Secretary of Industry and Commerce, until the Science and Technology Department is created. There is not yet established such a position; the creation of it is proposed.

(b) National Council for Standardization--this Council, still to be created, should assist the Coordinator mainly in the establishment of the annual program.

(c) National Institute of Weights and Measures--responsible for the maintenance of the measurement standards. The federal institute already in existence (INPM) could do the job if better equipped.

(d) National Norms Association--this should be private and work under the consensus principle, that all parties interested join in approval of the norms. The existing association (ABNT) should be used. It needs to have a much larger technical staff to assist the several committees, including the preparation of drafts of the norms. It needs also some financial support from system funds, since the contributions of the associate members are never enough to produce the required amount of work in time.

(e) National Service for Certification of Compliance--this Service should be a federal government office to avoid any kind of economic group pressure. It should not however, actually test products, but merely supervise the compliance contracts, the designation of laboratories to perform the tests, the award of the mark of compliance and the publication of marks in good standing. There is not an organization like this in operation; it would be created along with the system proposed.

(f) Testing Laboratories Network--these laboratories could be either private or governmental, but approved through an adequate procedure by the Certification of Compliance Service for specific areas of competence. Some of the existing laboratories could be used if upgraded, but some new ones should be created by adequate promotional activity.

(g) Reference Laboratories--few of the best government laboratories, federal as well as state, should be appointed as Reference Laboratories to execute the technical parts of the approval procedures of the testing laboratories.

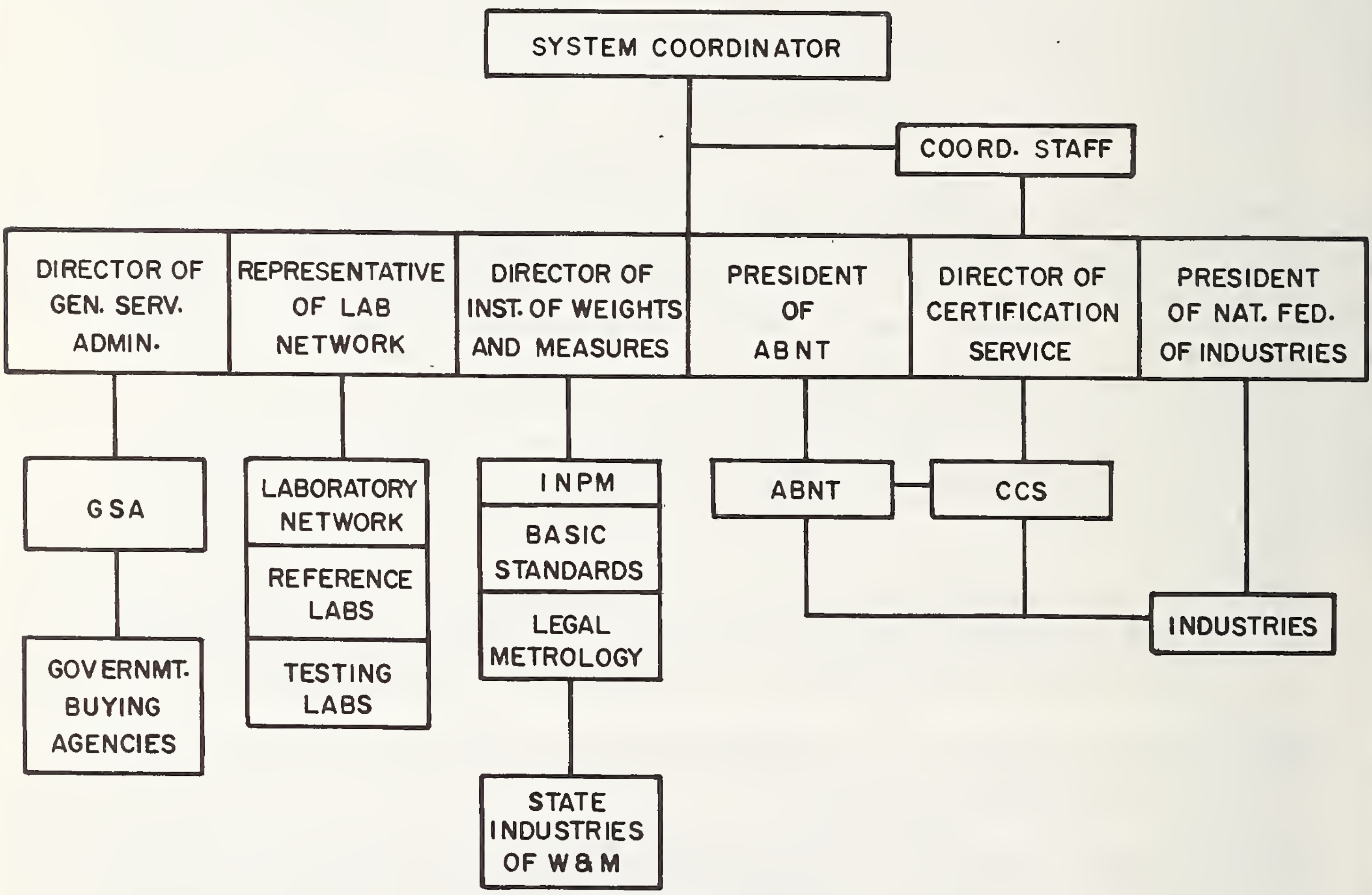

Figure 1

The funds to support the activities of the whole system would be the revenues from the contracts of certification supplemented by federal government money. As the system operation proceeds, it is expected that consumers will be increasingly aware of the benefits of certification, and less government money will be required. Whether a break-even point would ever be reached was considered to be a secondary question; with experience and the accumulation of data, an answer would be expected. Also recognized was the importance of federal government participation, not only in creating and funding the system, but also as a large-scale user.

The establishment of a national system of standards and certification in developing countries poses another problem of transfer of technology. It cannot simply copy the system of a highly developed country because of economic differences. The systems of the more advanced countries should be analyzed very carefully. With the knowledge acquired, a special project should be elaborated for the less developed country, taking into account its specific conditions. An important aspect is the determination of the adequate degree of government participation in the system, although partial participation is mandatory by the very nature of the problem. The United States, with its emphasis on private enterprise, has recognized this fact. The degree of government participation must be determined by the economic, social and political conditions of the country. Deviation from an optimum level could make the implementation of the planned system very difficult and lead to poor results.

To sum up this brief discussion I would point out that standardization and certification procedures contribute to economic growth and political stabilization, to the extent that they are basic for a better, faster, and more workable industrialization process.

SESSION 2 - THE SOCIOLOGICAL, ECONOMIC, AND MANAGERIAL ENVIRONMENT IN INDUSTRIALIZING COUNTRIES

Discussion

Co-chairmen: A. N. Ghosh and Edward U. Condon

Dr. Condon:

One thing that has been running through my mind is that there are so many countries in the world all going to do standardization work. Somebody should standardize the standardizers. I think we ought to give some thought to continuing machinery for keeping countries working together. That would seem like a natural United Nations function. On commodity standards and test method standards, the ISO is functioning, but we also need to look forward to something like a world organization of the national standards bodies so that they can exchange experience.

Too much of the talk about transfer of technology sounds as if it is all from the so-called developed countries to the so-called LDC's. I think the LDC's have many problems in common, and as they begin to discuss not just general philosophy but more specialized questions so there arises a horizontal transfer among them that can be very valuable.

Mr. Vannah:

If one industrialized nation has a certification program for products, then would not other industrialized nations accept that certification and use it, so that one would not necessarily need a complete certification program in all industrializing nations? This could minimize expensive duplication of product testing for certification.

Dr. Ghosh:

The question of recognition of certification marking by each of several countries has been engaging the attention of the British Commonwealth Standards Conference for many years. We have been urging that there should be this common recognition, but certification marking in general is under statutory law. The legal procedures have so far delayed agreement.

There was also an ISO Committee Number 73 which was titled Certification Marking. For many years Committee members struggled in vain. Again at the Ankara meeting in 1970 a group was established under the ISO Council to study the question of mutual recognition of certification marking. I have very grave doubts whether the legal people will allow it to come to fruition.

Adm. Maia:

I would like to add the comment that when the product is to be consumed locally, there is no sense in having certification from outside. However, all these national systems should be internationally compatible. They should be born and grow as compatible systems.

Dr. Rohatgi:

Mr. Kalmanoff of the World Bank made some comments about difficulties in import substitution or export promotion in the less developed countries. Dr. Ghosh reminds me that the Government of India has set up industry-oriented export promotion councils and federally controlled export inspection councils to promote export of goods from India and to assure their quality. The Export Promotion Council helps the industrialist who is a potential exporter by giving him financial help and a license, and making him aware of the markets. The Export Inspection Council inspects all the goods to be exported and affixes an export-worthy seal. Perhaps NBS could help by giving these councils information on standards used by importers in the USA.

Mr. Peiser:

NBS maintains a rather good key-word-in-context of standards written in the USA (Special Publication 329). We are not well indexed on standards written in all other countries. However, we have copies, for instance, of most Iranian standards, and perhaps half of the Indian standard documents.

Mr. French:

To what extent do industrializing nations accept as national standards the work of the IEC and the ISO and how quickly are these adopted in various developing countries?

Dr. Ghosh:

So far as India is concerned we have wide acceptance of the ISO and the IEC standards, and I think perhaps Iran does likewise. However, ISO and IEC are not international in the world-wide sense, but only in the sense that they are multi-national.

Related questions have also been asked. Why should we have national standards which take time to elaborate, and then coordinate them into international standards, which takes still more time? With technology advancing at the rate at which it is today, it is very difficult to have an international understanding before the technology has made it obsolete. Moreover, like it or not, the ISO and IEC standards are European and perhaps partly North American oriented, but the world consists of many other peoples too. The tropical and sub-tropical regions have special problems, characteristic categories of questions, specific development considerations, special infrastructure modes suited to their industries, and so on. So presently we have to take the international standards and adapt them to our local needs.

Mr. Felleke:

The procedures adopted in the presentation and elaboration of standards are quite closely associated with the overall situation of standardization. If standards have to be prepared in an administrative way by a centralized body then the presentation this afternoon concerning labor-intensive programs would be useful in the choice that should be made. If, however, standards are to be prepared through a committee program where interested parties--producers and users--participate then that procedure raises the question of whether there is a need to have a labor-intensive program. A capital-intensive program might be preferable.

Mr. Cali:

In Dr. Stepanek's argument for the less developed countries to use more labor-intensive devices, while the more developed countries use a capital-intensive economy, are there not some moral or social implications in that this difference in emphasis would tend to further fragment the work? Is there any discussion going on among economists on this score?

Mr. Kalmanoff:

I think the fundamental issue is that of a trade-off between objectives. In other words, if manufacturing in the LDC's is to be competitive with manufacturing outside, there is a real question whether the latest kinds of technologies, which usually tend to be capital-intensive, are not essential to achieve the goal. However, there are other objectives in the spectrum of the situation of the LDC's besides economic growth; one of these objectives is the creation of employment opportunities for the labor force. Some sort of a delicate balance has to be found between a maximization of efficiency and competitiveness on the one hand and the creation of employment opportunities in the LDC's which is a burning social-political issue that cannot be ignored. Of course, there are some economists who might say, Concentrate on economic growth, it is only through economic growth that you are going to be able to create employment opportunities in the long run. That is fine, but I quote Keynes, "In the long run, we are all dead!" The LDC's, in my opinion at any rate, cannot go all-out for maximum efficiency and competitiveness without regard to solutions of one sort or another for very serious unemployment problems which they all have.

Dr. Sabato:

Your comment implies that maximum efficiency is always related to one technology, the technology that is provided by, say, the USA or Europe. It does not make sense from the point of view of the technologist, that once you have developed one technology, you have the last word. In the developed world as well as in the underdeveloped world there are many examples of technologies that have been superseded by other technologies. Because technology is born from science, and science has no limits, you can in principle always optimize your factor condition, as economists say. If you develop the technology you have prepared for those factors, it can happen that the technology maximized for some factors are not the best for others.

The typical case is the automobile industry in the LDC's; it is one of the crimes against rationality that has been committed in the last 10 or 15 years. The LDC's have imported technologies which are obsolete and nonsensical from the point of view of local factors. For example, we import the technology of drawing sheet metal parts for cars; this technology was developed in Detroit, for a run of say, three or four million units a year. This technology has been used in Argentina for 40 thousand units, or in Brazil for 60 thousand, or in Mexico for 70 thousand. From the point of view of the economy of every one of these countries this is a crime, a real crime. We are paying a terrific price to import because we have been importing the wrong technology. There is a kind of mirage in the underdeveloped world that everything developed in the developed world is by definition the best, but this is a mirage.

I remember another case in point--the manufacture of tanks to store liquified gas. The technology used in this country or in Europe is the technology developed for making say 500 tanks a week. If you use the same technology in Argentina, you will make 50 tanks a month. Now, why do we import that technology? Because it is the technology that we hear about, and that then is regarded to be the best for us as it were by definition. It is not the best from the economic point of view. What kind of technology should you use to make the tanks? Well, we must use some other technology such as explosive forming, used in the USA to manufacture rockets instead of liquified gas tanks. The final goal is the same. My feeling is that this does not involve fragmentation more than that which exists already. I think the moral of the paper presented for Dr. Stepanek by Mr. Schmied is valid. If you use your own brain you will discover many ways to arrive to the same final product without necessarily losing efficiency.

Mr. Kalmanoff:

Well, certainly, Dr. Sabato, to the extent that there is no conflict between efficiency and labor-intensiveness, there is no trade-off such as the one I proposed and the problem is solved. Nevertheless, the general attitude that seems to prevail with respect to the general possibilities of substituting labor-intensive technologies with capital-intensive technologies is that this is more or less of a pipe dream. The only effective way in which industrialization in a labor-intensive way can proceed in LDC's is through the selection of particular industries which inherently are more labor-intensive than others, that will do the twin job of creating efficiency and employing labor. Now, I do not know whether this is really true or not. One of the points that I attempted to make in my paper is the paucity of either national or international efforts in exploring the extent to which the technological requirements of LDC's may be unique. The extent of such effort is minimal in relation to the total R & D that goes on in the world. Now, I do not know anything about the situation in Mainland China, but I have heard that there is a considerable amount of labor-intensive technology in some of their industrialization. In terms of volume of activity there is virtually nothing going on in the western world along these lines that would elucidate the problem. Maybe this is the big thrust that has to come in the future with respect to investigation of technologies for LDC's, because the problem of unemployment in such countries is daily growing more and more serious. Aside from the fact that we want to correct this from a purely humanitarian point of view, it can have very serious consequences of a political nature.

Mr. Arnold:

This has been a very interesting session and I am delighted to hear the various comments. I was particularly glad to hear Admiral Maia talk about the Brazilian attempt to set up an integrated standards organization. From the AID point of view, we are very interested in hearing the actual experiences of the countries that are represented here. Admiral Maia, what has happened since the plan was set forth? I wonder if you might make a few remarks about the status of the organization, and if it is not working perfectly, what some of the major problems might be.

Adm. Maia:

The results of the study that I talked about are still only on paper. The reason for it is the difficulty of changing. We have in Brazil a national standards organization, ABNT, which has worked for a long time without producing the results that the nation really needed. They supported resistance to change yet they would fulfill only part of a needed system instead of supplying the whole system. They had tried unsuccessfully to do the entire work from the norms formulation up to the marks of quality. Still, the men that were behind ABNT fought to keep the system, but fortunately time has weakened the strength of the resistance. We are now really starting to implement the report. I told you about the results of our study because I thought its main components should be part of any system of this kind. The study also shows that all components should be combined in the system and not be kept separate. This gave me the opportunity of talking about the importance of having the system funded and promoted by the federal government. That I believe is the only way a system like this can be established. We cannot expect that the private sector by itself would really fight hard to have a system like this until it is too late to have it. There is a lot of vested interest involved. In Brazil from the 1950's when ABNT started, up to now, not much progress has been made in the area of standardization and specification. The industries tried to set up some kind of an arrangement between the producers of parts and the firms that buy those parts, but otherwise we do not have any effort for the general benefit of the consumer. Many products could not be exported on account of poor quality. Another matter that I think is important is to recognize that the production of norms using only the work of voluntary committees working on their free time is not enough. It takes too long to produce a norm that way. We need professional people working on a full time basis, to study what has been written around the world on a specific product, and to develop a draft upon which a committee can work. From my experience when we did that study and visited some USA associations, this could be true even here. I heard a member of one of those committees saying that sometimes he had only the night before traveling to the committee meeting, drafted some notes for the discussion. We could go to the other extreme of making the operation completely governmental or completely professional without any committees involved, but this could be the path to an ivory tower. So I think that the best compromise would have some professional people writing the draft, with a committee to discuss the numbers that should be in this draft. I cannot say we are entirely right, on all proposals made, nor can I claim to have some experience on the working of the system, but we hope that with your help, we can start pretty soon putting to work a system at least similar to the one I described.

<u>Dr. Brady</u>:

It seems to me in trying to choose between capital-intensive and labor-intensive industrialization that you are trying to optimize a function that has different kinds of parameters in it. One kind relates to the technological efficiency of the industry and another kind relates to the social matters like the unemployment situation. How do you optimize a function that depends on such different types of parameters?

<u>Mr. Kalmanoff</u>:

I suppose the only short answer is that you might have to sacrifice some efficiency in order to get more employment. You may have to decide on your objective--the most efficiency and economic growth, or some lesser degree of economic efficiency and growth in order to achieve something toward realization of the other objectives. The latter might give you more employment that the former.

I would also like to tell this group about the development work of the World Bank. It is, of course, a financing agency, but it is also a development agency. The Bank management has been saying for some time that it ought to do something to support on an international scale research that may be related to serious fundamental development problems. Recently, jointly with UNDP and FAO of the UN it called together a group of some 15 nations and a number of other regional financing institutions, for example, the African, Asian, and American development banks, the European Development Fund (which is a financing arm for Africa), the DAC (which is a development systems committee of the OECD), plus the Ford, Kellogg, and Rockfeller Foundations, to see whether it would be worthwhile forming an organization to pursue the matter of priorities for agricultural research efforts of an international and regional type, and to exchange information on the financing of those efforts. I guess this move was spurred by the dramatic successes on new rice and wheat strains, in recent years, and the feeling that maybe more could be achieved in other areas of agriculture. This is a first step toward perhaps mounting a more ambitious international effort in research on development problems. The first step has been taken in agriculture, but it is not inconceivable that at some later date (and obviously I am not implying any commitment of the World Bank) a comparable effort might be started with respect to industry as it affects the less developed countries.

Dr. Rohatgi:

I speak on behalf of the technology educators in less developed countries on the point raised by Dr. Stepanek that students in such countries read books written by technologists from developed countries who preach labor saving techniques. I would appeal to the aid-giving agencies to fund the production of textbooks written by educators in less developed countries illustrated by examples from local industries. To date most of the help has gone into the production of Asian editions of books written by authors from developed countries, which does not solve the problem of relevance to the students in less developed countries of the region.

Dr. Ghosh:

We have found that the Indian standards, particularly the building designs and the structural standards used in the universities, including the IIT, have been based on British standards. For the last year or so, we have been campaigning to show to the teachers themselves examples of the useful properties of local materials, that could be relevant to the design and building codes. In a national standards institution we cannot undertake the task of educating a vast continent like India. What we are trying to do is to educate the educators, giving them worked-out examples. We do so in the metric system, not in the foot-pound system. This activity has been gaining tremendous momentum.

Mr. Daneman:

Those familiar with the cost of equipment in the USA should appreciate that it is not simply a question of adding import duties for arriving at costs of equipment landed in a less developed country. One needs a multiplier of perhaps 1.4 to 1.9. It is not unusual to find that spares can equal the cost of the hardware. On top of that, installation with U.S. aid can be extremely expensive. When you talk about a capital investment of a certain level here, you may have to consider a multiplier of four to arrive at an equivalent cost somewhere else.

Mr. Lovejoy:

The United Nations Development Program is currently administering the spending of around $250 million of international direct-grant aid funds annually, through projects executed by specialized agencies of the UN family in more than 100 countries and territories around the world. These projects cover a wide range of technical aid and so-called pre-investment activities; typically in resource development, training, agricultural development, and infrastructure and institution building. In the latter category are a variety of technological institutions many of which involve standards and other technical support services to industry.

From the point of view of possible NBS interest I would highlight two major kinds of aid activities. First, there is the technical support kind of activity including industrial research, standardization, and advisory services. Within the heading standardization, I would include preparation of specifications and codes, metrology, calibration, product testing, and quality control. This kind of industrial support service is provided by central government laboratories, local or central Weights and Measures administrations, commercial testing laboratories, specialized testing laboratories (e.g. for high voltages), industrial research institutes, authorized calibration laboratories, and so on. Technical support services have been assisted by the UNDP over the last ten years by major projects in 30 or 40 countries and smaller projects elsewhere, involving international consultants and specialists, overseas fellowships and seminars for local nationals; also by supply of essential items of equipment. These projects, although financed by UNDP, are mostly executed by the UN Industrial Development Organization (UNIDO) with headquarters in Vienna or by UNESCO with headquarters in Paris.

NBS has extensive experience in many of these fields and might be interested in providing short-term consultants (as it has already done in some cases), longer term specialist missions, and in assisting the placement of fellowships. The main problem is that in many cases the levels of sophistication and capability between NBS and the corresponding institutes in developing countries might be mismatched. We have already heard from Dr. Tabor of his reservations based on his own experience of reproducing in Israel an NBS-type institute for whose services there has been relatively little demand, especially in view of the revolution in commercially available instrumental precision in the last decade.

Secondly, I would briefly draw your attention to a major industrial technological problem facing many developing countries. This is the problem of the appropriate technology (and the related question of intermediate technology) for a particular need. In a number of industrial fields including iron and steel, cement, pulp and paper, oil refining, petrochemicals, fertilizers, power production, farm implements, automobiles, and some kinds of consumer products there are specific needs for factories designed to specifications different from those needed in developed countries. In particular the need is for relatively small scale production units, corresponding to small markets, sometimes with unconventional raw materials, and preferably labor-intensive rather than capital-intensive. Parenthetically, I might emphasize that these considerations apply only to factories producing for the local market. The export factories are likely to be as large-scale, capital-intensive, and up-to-date as any in the advanced countries.

Now in many advanced countries the small scale technology does not exist--or has become obsolete. For example, a number of African countries are interested in small-scale cement production in the range of 10,000 to 30,000 tons p.a. whereas the smallest rotary kilns commercially available are for 100,000 tons p.a. Development work is now going on in some countries, including Australia and India, to revive the vertical shaft kilns of earlier times (and in one form still widely used in Germany), but adapted to different raw materials such as less-than-pure-limestone, or oil or gas instead of coal.

On the other hand, recent developments in iron and steel technology such as pre-reduction and electro-smelting are of considerable interest to both developing and industrially advanced countries. They hold promise of small-scale, cheaper plants which can be located close to markets and do not require metallurgical coke, which is in increasingly short supply.

These areas of industrial research and development have in certain cases been supported by UNDP to a very limited extent, dictated by limited funds. It may be that in some fields NBS, possibly in collaboration with industrial or contract research laboratories, could perform a service to developing countries.

SESSION 3 - MAKING SCIENTIFIC AND TECHNOLOGICAL MEASUREMENT MEANINGFUL

Paper 3.1 - Overview - The Economic Role of Metrology Capabilities

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We are entering a period of active development of the countries of Latin America, Asia, and Africa, many of which were long held back by their colonial relationship to the major powers of Europe. It is fashionable to refer to them as "developing" nations, to avoid the negative connotation in describing their present condition as "underdeveloped" or "undeveloped."

I do not like the negative connotation, with the implication that the advanced nations are "developed", if this connotes that they are no longer developing; that their development has reached a kind of plateau above which it will not rise much farther. I do not believe this needs to be or ought to be the case. I believe that we in America have still a long way to go in improving the quality of life by better utilization of labor and natural resources for improved welfare of the entire population in the development of instruments of national planning for the furtherance of this goal, in making a better contribution to the agencies of international cooperation of the United Nations, and in making progress in realizing the futility of trying to prepare for military solutions of international problems on which we alone have wasted more than a trillion (10^{12}) dollars since 1945. These are some directions in which the United States of America needs to continue to be a developing nation. I hope that the U.S. will not only continue to develop in the future, but will also increase the level of assistance which it extends to the new countries whose development is not as far along as is ours. I want to see the developing nations develop, not only from a desire to see their peoples live better lives, but also because, when they do so, their creative endeavors will add to the total storehouse of human knowledge on which the future progress of all of us depends.

By coincidence I have just spent the past two weeks in Vienna, at the headquarters of UNIDO (United Nations Industrial Development Organization). There a group of us were working on policy questions related to improving the capability of that agency to foster the wide dissemination of technological information about modern factory processes, in order to assist industrial enterprises, both actual and prospective, in the newly developing countries. In our NBS/AID Seminar here this week we deal with a more specialized part of this general question. Recognizing the dependence of modern industry on institutions such as NBS, or the National Physical Laboratory in London, or the Physikalische-Technische Bundesanstalt in Germany, or the Bureau International des Poids et Mesures in France, or the five standards laboratories and 129 calibration centers in Russia, one of the prime essentials to industrial development of any new country is the establishment of the technical basis for uniform standards of weights and measures, including electrical measurements. This is a sine qua non without which industrial development cannot occur. It is impossible therefore to isolate it from the economy as a whole, or to try to put an economic value on this portion of the national activity.

As contrasted with the Western European nations, the United States is a recently developed country. The industrial revolution started in England in the mid-eighteenth century. America consisted then of a few English colonies in the East and of some Spanish colonies in the West, plus the French colonies of Quebec and Louisiana. There was great interest in European invention in colonial America, and some invention here. Most of the early steps in the industrial revolution in America in the first half of the nineteenth century were based on ideas imported from Europe.

Industrialization cannot happen simply through importation of technique and capital. A necessary condition is that there be a revolution in agricultural production by which the people can be fed on a more adequate nutritional basis than obtains in many countries at present, through the efforts of a smaller fraction of the labor force. Figure 1 is a graph of the fraction of the economically active population that is engaged in agriculture over recent decades, for various countries. Source: FAO Yearbook of Production, 1965.

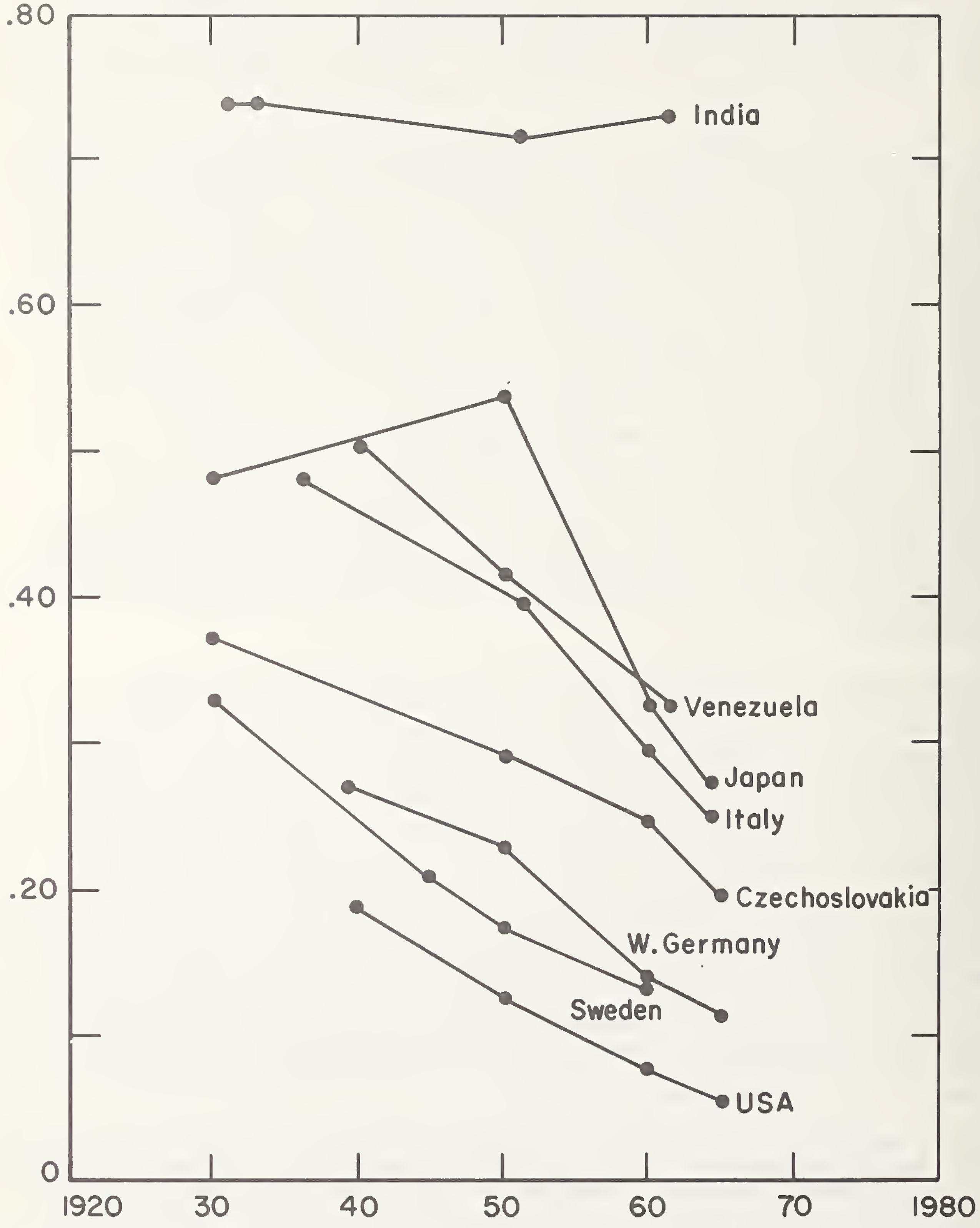

Figure 1. Ordinates: Fraction of economically active population engaged in agriculture. Abscissas: Years. Source: Food and Agriculture Organization (UN), 1965 Yearbook of Production.

Of course, this fraction is a very crude index. It makes no allowance for differences in the adequacy of nutritional standards in these countries, for variations in the fraction of the product that is food instead of textile fibers, or the fraction of the product exported or imported. Nevertheless, some striking comparisons emerge:

(a) the absolute smallness of the USA of the fraction, and its recent rapid three-fold decline;

(b) the rapid rate of decline, though from a higher absolute level, in several well-developed countries of Europe, and in Japan;

(c) the very high absolute level and its lack of decrease so far in India, which I presume is fairly representative of countries of Asia and Africa that are at an early stage of development.

The planning bodies of every developing country should study this figure carefully, and plot the corresponding figures for their own country on it, working out supplementary measures of the nutritional adequacy of the actual food output in relation to the needs of the population, and the growth rates at which various populations are increasing.

In the developing countries in general there is an extremely low level of agricultural technology. This is mostly due to the ignorance of the farming population. Agricultural education on a large scale is needed. Modern American agricultural education did not start until the mid-nineteenth century. A great step forward was the Morrill Act of 1862 which made major federal land grants to encourage the states to set up schools of agriculture and engineering; 69 such colleges were organized under the act. The Hatch Act (1887) provided for federal aid to agricultural experiment stations, and the Smith-Lever Act (1914) provided for agricultural extension services to spread the knowledge of farm technology to rural areas. These things are old history, but lessons from the distant past must be learned in order to understand why such a small part of our labor force is required to feed our people.

Please do not think that I think our record is perfect in this matter. There is in the USA a vast amount of poverty, malnutrition and illness, that could all be ended in a few years if our policy makers were not so preoccupied with making war and preparations for war. Many U.S. citizens are badly undernourished, while the Federal and State Governments, in 1969 for example, paid out more that \$3.7 billion to farmers for not raising certain crops. This is to be compared with \$2.5 billion spent by AID in 1969 on economic assistance to other countries.

Another index is shown in Figure 2. Here the life expectancy at birth in various countries is shown plotted against the date. Life expectancy is one index of the general physical well-being of a population and hence of the ability of its individuals to contribute to further improvement of that well-being. By coincidence the USA in 1850 had the same low level, (m,w) = (38,40), that the Congo had a century later in 1952. Here (m,w) means the life expectancy in years for men and women respectively. The data for the United Kingdom (not plotted) closely parallel those of the USA. The slow, steady rise in these two developed countries partly reflects the fact that medical knowledge was rather poor prior to 1850. It would be useful to analyze how much the improvement in the USA and UK might have been speeded up if the fullest social utilization of expanding medical knowledge had been made during the first half of the 20th century.

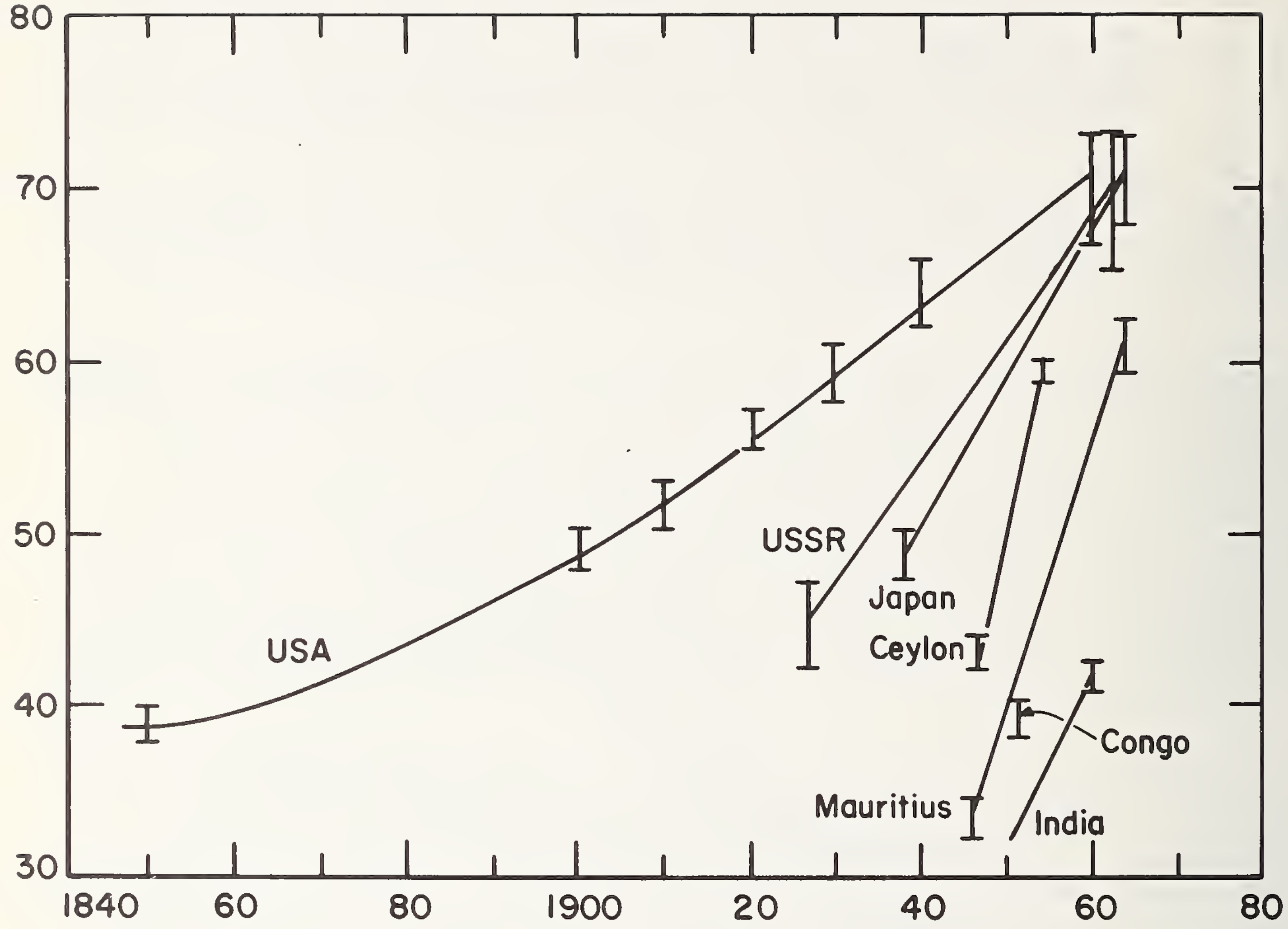

Figure 2. Ordinates: Life expectancy at various ages. The vertical bars extend from the value for men (m) to the value for women (w); m < w in all cases except Ceylon and India where m ⩾ w. Abscissas: Years. Source: UN Demographic Yearbook, 1965.

What is striking and encouraging here is the rapid rise in life expectancy which has occurred in USSR, Japan and Ceylon in the last three or four decades. Starting at roughly where we were in 1880, these countries have made rapid strides, so that as of the mid-60's, they were essentially caught up with the USA. Starting at a very low figure in 1950, India is improving rapidly, and should be up to our present level before the end of this century. Most remarkable is the progress made by Mauritius, going from (32,34) in 1946 to (59,62) in 1962. The rate of progress in improving health conditions in developing countries as shown in Figure 2 should serve as an inspiration to the planning officials of less developed countries.

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Let us turn now to more specific consideration of the functions of national standardizing laboratories in less developed countries. These may be discussed under two major headings: (a) establishment of measurement calibration services within a country which tie in with internationally adopted units of measurement, and (b) development of standard specifications for commodities and manufactured goods in international trade.

Again it is important to realize how recently the USA has become a developed nation. Our NBS was not established until 1901. It was therefore a half-century old in 1951, when I resigned as director, and it will be just three-quarters of a century old in 1976 when the USA will celebrate the bicentennial of its Declaration of Independence. All of you who are concerned with development of such services in your own countries will find it fascinating to read the history of NBS by Rexmond C. Cochrane. It is called "Measures for Progress", and was published by the U.S. Department of Commerce in 1966. I understand that copies are available for all our guests. I am sure that reading about our early problems will stimulate your thinking about and analysis of the problems you face.

There is something about human affairs that usually requires several decades for major change. We are rightly impatient, and should try in every way we can to speed up the process, but we must learn to expect that, try as we will, major change cannot be effected in a year or two. I am reminded of the story of two Scots, partners in an old line manufacturing business, who employed a research chemist. About 11 a.m. of his first day one partner said to the other, "Shall we go see whether that research fellow has discovered anything yet?" The other replied, "No, let's wait until after lunch!"

Research people seem slow at times. But I think that they are not slower than politicians or business executives in taking up new ideas. In fact, I would say that they are usually much faster. For example, research people, the world over, use the Metric System. It is the legal basis for the antiquated units of weights and measures to which we cling in the USA. The British, Canadians, and Australians are, at last, launched on a program to adopt the metric units for general use; but the USA is still studying this matter: we will probably be the last nation in the world to do what we should have done a century ago!

Every year in this country a number of houses burn to the ground because of the lack of standardization of screw threads on fire fighting equipment and hydrants. I hope that you who here represent the less developed countries will not allow this kind of free enterprise anarchy to get a foothold in your countries. In many of these countries industrialization can only go forward on the basis of national planning and centrally controlled investment, so government will be able to require suitable standardization of measures.

Industrial research and development on a large and well organized scale is less than half a century old in America. Such an enormous establishment is now available that it is hard to realize that before 1920 only a handful of industries had their own research laboratories, and those that they did have were only small beginnings. In that period, NBS likewise small, played a stimulating role toward new industry in a way that was rather different from that which it mostly plays today. Its role then was more like that which your new standardizing laboratories will play in countries where industrialization is just beginning. Although starting later, I expect your rate of development will be faster than ours was, in a way resembling the greater rate of increase of life expectancy that is shown on Figure 2 for the countries whose modernization started relatively recently.

We have now in America an enormous electronics industry. In the early days NBS played a role of major importance in the development of radio. Its Circular 74, Radio Instruments and Measurements, published in March 1918, was for many years the standard work from which all radio engineers learned the subject.

Early American research on aerodynamics and aircraft flight was done by NBS. In World War I, a new little agency called NACA, National Advisory Committee for Aeronautics, was established by an Act passed by Congress. This was a spin-off from NBS. NACA later got into the space business in a big way so that most of you know it as NASA. You who are impatient to see large things happen in the underdeveloped countries can see in what a small way some things get started. This Act of 1917 outlined a vast array of duties. They included everything to do with aviation, not merely flying, but motor power, navigational aids, radio communication between planes, and all that. Then they ended up by appropriating "$5,000 or such portion thereof as may be necessary" to solve these problems! That is how, at least in our country, the technical people get their feet in the door: there may be a lesson in that for some of you who are just getting started.

One thing struck me for the first time this morning, when one speaker was contrasting a free enterprise country and a centrally planned economy like that of Soviet Russia. The difference is actually even bigger in some respects than you might think, because this is a nation of 50 semi-autonomous states. The USA is a kind of grown-up United Nations where the central authority has gradually assumed more and more power. Younger people looking at this nation now probably would not realize how much of the thinking of older Americans is still influenced by the autonomy of the states. We are a nation of 50 states, each of which has a great deal of separate authority. So the points made by some speakers this morning that NBS has always had to win acceptance for its viewpoints, had to win people over by persuasion, as contrasted by exerting central dictatorial authority, is a very genuine one. It lies deep in our system. It is an additional point over and above the point that we have more private capitalism as contrasted with governmental action. Even in the sphere of governmental action, we are still a somewhat loose republic of states. Some might say we are as ineffectual as the United Nations. Another way of looking at it, if you think that we have evolved in a reasonably effectual way, having had almost 200 years to do so, is to conclude that there is great hope for the United Nations. I really think there is hope, but I also think one should not be too impatient about it.

This need to persuade, I think, has influenced the way in which NBS has worked with the agencies. It has been frustrating at times for us: I am sure Allen Astin, who is sitting in the back of the room reminiscently pulling on his pipe, knows that there are times when any head of a bureau would rather have some dictatorial authority to ram things down peoples' throats. But if you do not ram things down their throats, but win acceptance by persuasion, even though it is a lot more trouble, in the end the result is better.

One of the most encouraging things that I have experienced in a long time is the development of an international dialogue of the sort that we have in this Seminar and the sort that I had the pleasure of taking part in last week in Vienna through UNIDO. Of course, the little conference that I attended in Vienna was devoted to a rather narrow topic. It had to do with the procedures and mechanisms by which UNIDO could most effectively transmit industrial information to the less developed countries in areas broader than metrology. One of the most disappointing features to me in the discussion there which I also found reflected in some of the conversations here, is that the whole discussion was carried on quite as if there were no universities in these countries. To this restricted view I object very much. I happen to be a product of one of the western universities, one of those we used to sneeringly call "cow colleges." What I found in

Vienna was a feeling on the part of some that many universities are the twentieth century analogue of monasteries, not agents of progress and not technically advanced and progressive, that they are isolated as ivory towers without identification with progress within the country of which they are a part. There is a tendency not to think of them as being instruments of progress, of industrialization, of engineering development, and as fostering new enterprises. I, myself, have never lived in anything that you would call an underdeveloped country, unless you call the western part of the United States underdeveloped, say New Mexico, my native state.

As a result of long discussions I became persuaded finally that it really is an attribute of the universities in many of the countries in question. If that is so, then that is one of the major problems; because we are not going to achieve great development and great industrialization before about two decades. This is the time we need to develop the right kind of human product from the universities. If the universities of the various developing countries are so backward, then what we need to do is to supplement them with institutions that are more modern, progressive, and technically oriented. I am not thinking now of engineering only, the same is true of agriculture and the health professions, though our concern here is mostly with the physical sciences and their engineering and manufacturing applications.

Earlier I mentioned the Morrill Land Grant Act of 1862, that made grants of public land, which later became quite valuable to the state universities in return for their being committed to a program of engineering and agricultural instruction. This commitment was not to the exclusion of having professors of literature and philosophy and other such subjects but primary emphasis was on subjects relevant to industrial development. The universities were also given major financial support from the Federal Government. If the universities in the newly developing countries are too much like ivory towers, something must be done about it. It seems to me that one of the great needs of the new countries is a thoroughly developed set of institutions for training people, not entirely at the highest research level, but at the level for technicians or junior engineers, in all major fields--agricultural work, health work, industrial manufacturing work, and so forth.

I would greatly appreciate your comments on a proposal that I am trying to push with members of our Congress. As all of you know, a good share of the post-war period has been characterized by an atmosphere of military tension between the East and the West, meaning between the Soviet Union and the United States. There have been big military expenditures on both sides, a tremendous waste: two-hundred billion dollars a year is now going into military expenditures by the countries of the world. All that represents resources which might be used for the kinds of constructive purposes that we here are interested in, but which are otherwise squandered. The countries of the world carry big armaments because they fear each other, and they fear each other because of the big armaments. The biggest problem confronting the world today is how to reduce these tensions so that we will not feel armaments to be necessary, so we will not waste money on such things. Then these resources will become available for positive and constructive development efforts which at present can only move at a snail's pace.

The suggestion that I would like to make is especially appropriate before this group because it calls for cooperative action, not unilateral action just by the USA, but cooperative action between citizens of this and the people of other countries. In the past two decades we have invested a tremendous amount of money in the physical properties of overseas military bases. I do not know where they all are. I do not mean that they are secret, it is hard to keep a base secret, but it is just that I do not know where they all are. There is a nice one in Ethiopia. We gave up one in Pakistan, the one from which Francis Gary Powers took off on his famous U-2 flight. We were invited to leave one we held in Libya, and have accepted that invitation. In the next few years we are going to see a great pulling back from these bases. They are tremendously valuable physical properties, I do not know the total investment; the bases we built in Spain cost us over a billion dollars. The terms on which our country made lease agreements with most of the host countries where they are located were such that when we give them up for whatever reason, they revert as physical property to the host country. The investment in the improvements is ours, the investment in the land was theirs. They will get it all. A great gain could be made for the various countries if, instead of having these bases simply continue as great military installations, and hence become a big drain on their resources, they would find the means to convert them into technological training centers for training the vast numbers of people that are going to be needed in order to carry on the kinds of development these countries are going to need. If we really face the question, we must realize that the level of activity on development is really not much more than a tenth of a percent of what it ought to be to achieve the results we would like to see achieved, say in the rest of the present century. So what we need is a new source of resources to develop such things. This is a thing the United States cannot do alone because we are committed to give these bases over to the various countries when the leases expire. If the countries which find themselves coming into the possession of such property do not do anything about it, the bases will just go to their generals who will use them to enhance the prestige of generals. However, if we can convert these properties into major educational institutions for a vast training program, including some research and some education, I think that would be a great thing. Please tell me whether and how this could be done in your countries.

That is the main point that I wanted to cover. I realize I have not talked much about the specifics of the conference in Vienna. Some of the participants proposed establishing enormous centers of documentation in developing countries that would be as big as our Library of Congress, with millions of documents; yet they should know very well that there are very few people in these countries who are prepared to read the documents, or are likely to read them. We had in this country closely related to the university scheme of those cow colleges county extension agents, people who were living in an individual county. They conveyed agricultural knowledge to farmers and operated demonstration farms. No matter how backward a farmer was, he had to admit that if he saw better crops growing and better yields in the farm next door, there must be something in that knowledge. This type of technique I think we need presently for the transmission of technology, as contrasted with enormously great centers of documentation; beautiful libraries that almost nobody uses.

There is a great deal of work to be done and it is very, very encouraging that the work is being started, but it is sometimes discouraging when one sees how much there is to be done in relation to the present efforts that are being made. However, I am very happy to be here to take part in this Seminar.

Paper 3.2 - Needs for Measurement Controls in Developing Industrialization

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1. Introduction

This presentation will emphasize the need for careful attention to the application of metrology, the science of measurement systems, in a much broader context than is normally ascribed to a metrologist. The objective is to impress you with the fundamental need to control the entire process of product testing or monitoring if economically sound products are to be delivered at competitive prices to satisfied customers. It should also become clear that the careful, rational, and controlled application of metrology to all technical efforts, commencing with research measurements and culminating in mass production product testing, is crucial both in developing industrialization and in maintaining that industrialization, once developed.

Because metrology is an integral part of research and development, design evaluation, quality control, product certification, product tests, and data feedback for product improvement, its careful control and application cannot be overemphasized. In the United States, too little attention has been paid to the application of meaningful controls on measurement and product testing. This has resulted in greater costs than are necessary in the goods that we produce, through unnecessary rejection of good items and undesirable acceptance of bad ones. Proper economic and technical guidelines must be made available to minimize faulty testing products without incurring excessive testing costs.

The only meaningful determination of product quality prior to product consumption is that made by testing and measurement. Other quality detectors exist but the discovery usually comes too late to alleviate customer dissatisfaction or soaring costs. However, managers may often rely blindly on the reports turned in by their test personnel. Unless these measurements are consistent and reliable over long periods of time, both the manufacturer and the public suffer through higher costs. It is for this reason that government and industry leaders must recognize the role that measurements play in the financial health of companies and the economic strength of nations.

2. The Need for Controlled Measurements

Applied metrology is the thread which ties together product development, product manufacture, process monitoring and product testing, to insure that the item actually delivered is reasonably similar to the prototype that was developed and the item that was promised. "Product development" refers to research, development, test, and evaluation leading up to the construction or improvement of one of an item based on laboratory tests, measurements, bread board layouts, etc. "Product manufacture" means the production design, engineering proof testing, and factory equipment set-up to build more than one of an item. "Process monitoring" means the checking of the quantity production processes as they occur, so that proper constituents are being mixed and proper controls are maintained on such parameters as temperature, humidity and feedrate. "Testing" refers to the evaluation of the finished products through inspection and physical measurement to confirm that they perform to desired specifications, and satisfy the original design and development objectives.

Some items may not require testing, if the manufacturer is willing to run the risk of customer complaints, in lieu of incurring testing expense or if it is more economical to provide free replacement service when the product is bad. Objects such as low-cost watches, cameras and radios have been treated in this manner. On the other hand, the need for testing is extremely critical where the product affects personal safety, as in ground and air transportation equipment, communication systems, life support systems, intensive care equipment for hospital wards, and national security systems. In such situations it is essential that proper relationships exist among research and development measurements, design specifications, production control specifications and product tests. This requires proper control of measurement errors during research, the careful writing of testing specifications, the proper selection of measuring equipment and measuring methods, and the assurance that the tolerances set are compatible throughout all the stages of manufacture and use.

3. Effects of Measurements

Especially critical is the establishment of test tolerances in relation to design or process tolerances. Large economic losses can and will occur unless these tolerance relationships are controlled very carefully. Based on studies performed in 1955, I have since applied the work of A. R. Eagle described in his paper "A Method of Handling Errors in Testing and Measuring" appearing in Industrial Quality Control, March 1954, and that of F. E. Grubbs and H. J. Coon in their paper entitled "On Setting Test Limits Relative to Specification Limits" appearing in the same issue of Industrial Quality Control. Based on my experience and observations since then, I am convinced that those studies are still relevant and valid. They showed that startling effects on the validity of tests occur when test tolerances are varied in relation to design tolerances.

Take a hypothetical manufacturing process in which at least 95% of the outgoing product is expected to be good, and up to 5% may be bad. Assume that the probable errors of the measuring equipment used to test the product are determined at two-sigma confidence limits. Assume that the product will be tested using measuring equipment whose probable error is one-fourth that of the original design specifications for the critical parameters of the product. Figure 1 shows what happens when the testing tolerance limits are shifted in relation to the design specification limits. At the point labeled "Inside", the test tolerances have been located inside the design specifications by an amount equal to the error of the test equipment. The point labeled "Equal" depicts the case where the test tolerances are located equal to the design specifications. The point labeled "Outside" shows the results of the test tolerances being located outside of the design specifications by an amount equal to the error of the test equipment. The solid line shows false rejections; i.e., products which are really good, but which will be falsely tested by the very make-up of the planned testing process. The dashed line shows false acceptances; i.e., bad products which the testing process falsely says are good. Thus we see that at the "Inside" point, the false rejection of good products is 10% of the total quantity of the product, but reduces sharply as the tolerance relationship moves to the "Outside" point where only 0.05% of the product will be falsely rejected. Meanwhile, false acceptance of bad products will increase from a value of 0.02% at the "Inside" point to 3% at the "Outside" point. This obviously has quite a significant effect on apparent product quality and will have a serious effect on product costs and management decisions.

Having seen the effect of shifting the location of the test tolerances relative to the design specification limits, let us now examine Figure 2 to see what happens if that relationship is held constant and if the allowable error of the measuring equipment is varied. Assume that the test tolerance is held constant and is equal to the design specification tolerance.

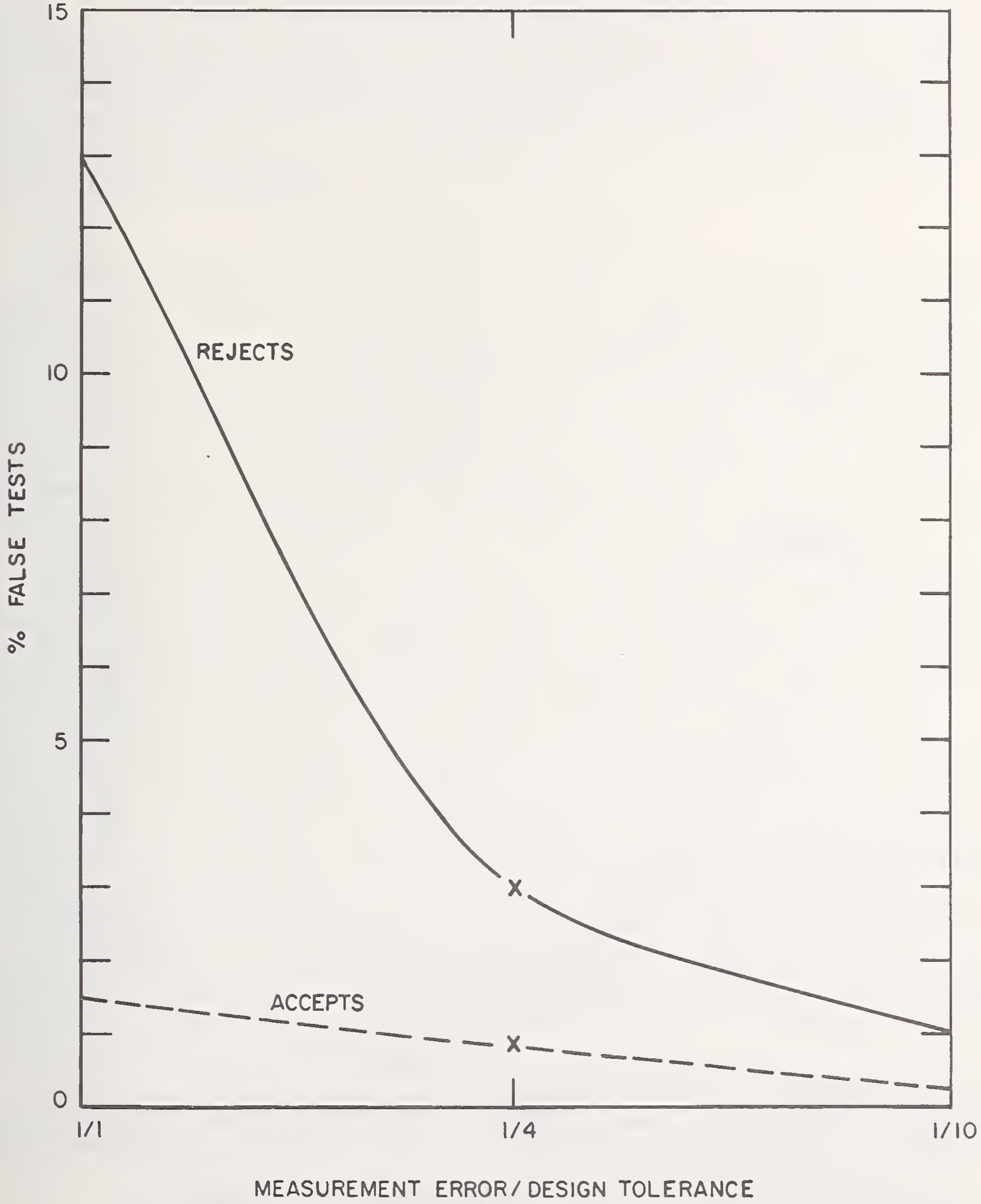

Figure 1

Relative Location, Test Tolerance to Design Tolerance

Figure 2 shows what happens when we use three different measuring systems; one whose error is equal to the test tolerance (1/1), another whose error is one-fourth of the test tolerance (1/4) and yet another whose error is one-tenth of the test tolerance (1/10). We find false rejections which vary from 13% at 1/1, to 3% at 1/4, to 1% at 1/10; meanwhile, false acceptances go from 1.6% at 1/1, to 0.8% at 1/4, to 0.3% at 1/10. Again, drastic changes occur when we use test equipment of varying degrees of accuracy to test the same products. While it is evident that a 1/10 relationship yields the lowest false acceptance and rejection levels, the added cost of using higher accuracy test equipment over lower accuracy test equipment may offset the gains involved. For every product some correct combination exists. Control of these factors is absolutely essential to the validity of the test, the quality of delivered products and the costs of production and testing.

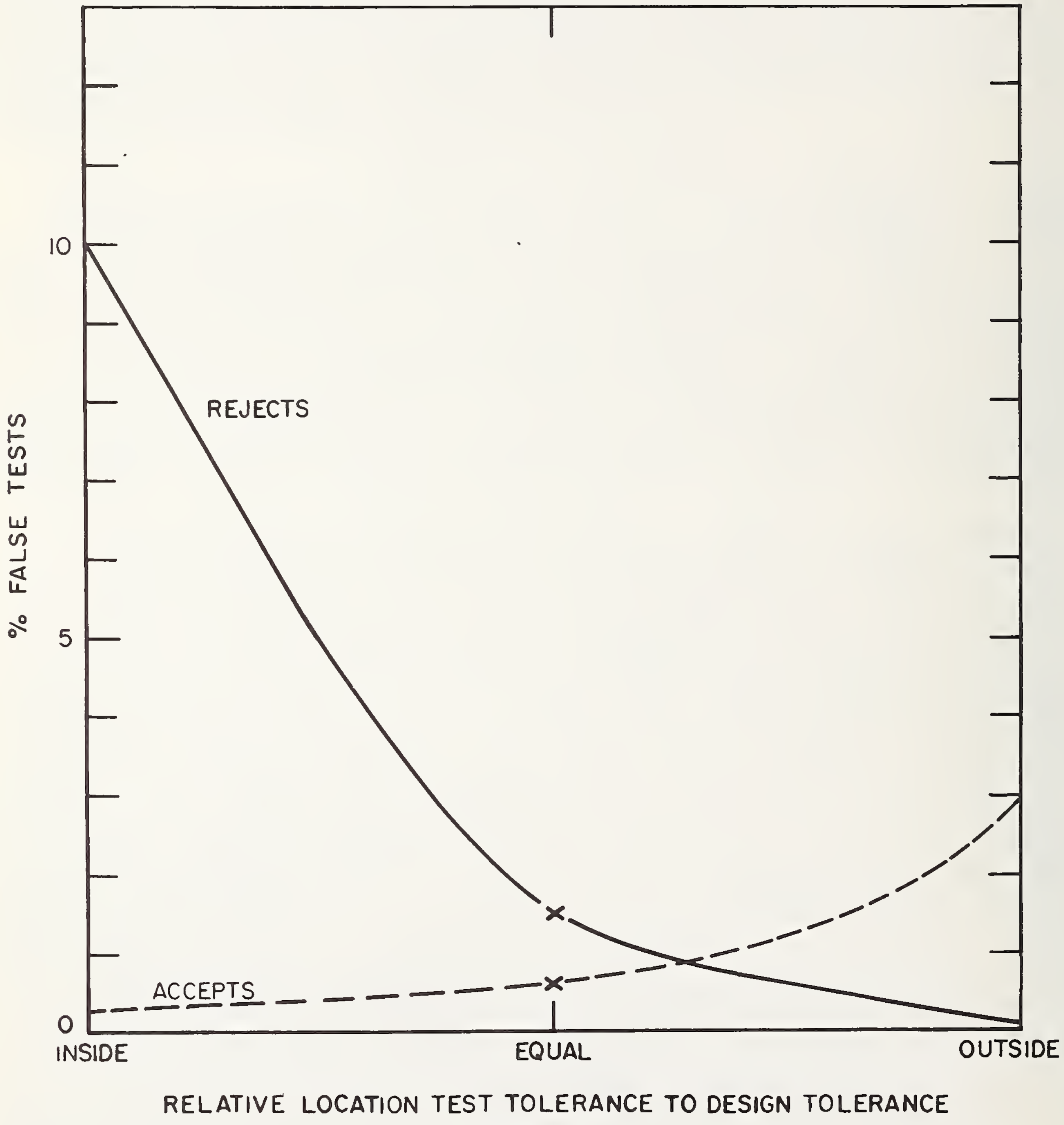

Figure 2

Measurement Error/Design Tolerance

Another concern of the metrologist is that the errors of measuring equipment generally increase as a function of time, and must be periodically tested or calibrated to insure that they retain acceptable accuracy. So, all instruments must be referred periodically to common measurement standards. The need for this can be seen if a bearing is made at one plant, an axle is made at another plant, and both parts are assembled onto a wheel hub at still a third plant. Unless all three plants have measurement compatibility assured by controlled reference of all measurements to common standards with known and controlled errors, chaos in the assembly process is bound to result. Future provision of spare parts when one of the three components wears out will demand continued measurement control. It is therefore essential that the design tolerances, test tolerances, measuring instrument errors, and the standards used to test the production measuring instruments are all linked together in a carefully controlled network. This must involve common techniques of measurement as well as common units of measurement.

4. Application of Controls

How can adequate control of test and measuring processes be achieved? First, design tolerances must be realistic and economic. Design personnel must be informed about the measuring equipment errors they will encounter in production and test processes. Adequate guidelines must be given to aid them in avoiding unrealistic design tolerances which cannot be applied when the design subsequently becomes a product. Trained metrologists should work on teams with design specialists. Both designs and test plans should be devised at the same time to insure that products are not too sophisticated for the state-of-the-art of measurement or for the instruments that are available within economic limits. Carefully documented testing procedures are needed so that relatively unskilled people can perform the tests, following guidance provided by metrologists.

Next, it is necessary to insure that proper testing and process monitoring tolerances are established. Handbooks should be prepared to aid test personnel in setting up consistent testing tolerances with a full awareness of their effect on product quality and cost. Such a handbook should include convenient nomographs, and sets of measurement tolerances related to the errors to be expected in specific measurement processes. The handbook should also include the effect of varying environment on the measurement errors. The allowable test and measuring equipment errors should be related to design tolerances, so that equipment can be selected to meet the error requirements. The guidance handbook should also give examples of the economic and quality tradeoffs to be considered in the usage of test and measuring equipment of varying degrees of accuracy, including the cost of a calibration structure to support those measurements. A feedback system should be established to adjust the test and design tolerances to compensate for state-of-the-art or economic limitations as they are discovered. Where necessary, the product should be redesigned, or its performance specifications altered, until an adequate balance of economics, quality, marketability, and competitive position can be achieved. Where it is proven that the performance limitation of test and measuring equipment is affecting competitive position, effort should be focused on developing new measuring equipment.

Finally, a suitable test and measurements structure must be set up to refer all measurements to a common standard. For this, at least the following three steps are needed:

a. Select a minimum number of layers in the structure, consistent with logistics, with prime attention focused on the basic layer where research/development and production measurements take place. Be sure these measurements are correct; they are the most important in the structure.

b. Second, establish a periodic calibration program for all test and measuring equipment to insure that its precision remains within prescribed error limits. Establish how often to test each item, provide documents on how to test, specify what standards to use, and arrange to test the standards themselves periodically. Insure that a centralized point of reference is available to support the accuracy of the entire measurement system.

c. Third, insure that trained measurement specialists are available to develop and maintain guidelines for the test methods to be used by others. The same specialists should be used to develop new test and measuring equipment necessary to meet demonstrated accuracy requirements. Training should include not only one of the usual engineering or physics curricula, but should extend to a working knowledge of statistics and its application to measurement. Systems analysis, especially as it applies to the economic and financial aspects of manufacturing and testing would be useful. Design engineers also should receive formal training in measurement techniques and practices so that they will appreciate the effect of their tolerance selections on overall quality and cost.

5. Conclusion

Metrology represents an essential national resource. It is a key element in every aspect of industrial development. Without it, technological chaos results, and the required uniformity of material, methods and dimensions cannot exist.

Adequate guidelines, coupled with the intelligent application of measurement controls, will provide better quality products at reduced costs. The accuracy of measurement instruments must be consistent with process needs and the tolerances of design and test must likewise be consistent. Too much accuracy can be as expensive as too little. The need for greater accuracy in specific areas will create demands for new work on measurement equipment and methods. However, a rational measurement control program will properly identify where that need is, so that proper priorities in applying limited resources can be employed.

It is my opinion that too little has been done to date to fulfill the requisites of measurement control. Too few guidelines have been made available to design and test personnel. The failure to adopt a rational approach to establishing testing tolerances in appropriate relation to design tolerances has created confusion, from the product test level through the entire national measurement structure. This has resulted in excessive accuracy in some measurement areas and deficient accuracies in others.

Metrology is a powerful technical tool in developing industrialization. Lack of it will assuredly result in manufacturing chaos. Misuse of it through ignorance will prove highly wasteful of national resources. If it is to be used as a meaningful force to accelerate and maintain industrial development, its value must be understood, it must be nurtured and it must be controlled.

Paper 3.3 - Problems in Establishing Accurate Measurements in Industrializing Economies

A Case-Study of Basic Standards Activities in the Israel NPL and Some Possible Lessons to be Learnt

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Background

The NPLI was conceived in 1947 and initiated in 1950 as a double-functioned government institution along the lines of similar institutions abroad:

(a) to establish and maintain physical standards (for the purpose of raising the precision of local industry and of meeting international needs), and

(b) to conduct applied research to advance the economy of the country.

For the purpose of this seminar, we limit ourselves to a discussion on the first item. Furthermore, as the standardization of products and procedures is the province of the Israel Standards Institution, the NPLI has concerned itself with the standardization of measurement, i.e., physical standards, metrology, calibration services, and occasionally, the evolution of special measuring methods including the decision as to what measurements to make.

Upon short visits by the first author in 1949 to the NPL in Teddington and the NBS in Washington, it must be recorded, the directors and all the staff members were exceptionally helpful. Basic equipment was ordered (mostly in the U.S. and Switzerland) for the setting up of a basic standards facility on classical lines, with the accent on engineering metrology, thermometry, and electrical units. A modicum of common sense was (hopefully) applied in not attempting to duplicate all the primary standards; secondary standards calibrated by the NBS or NPL were considered more than adequate for most purposes, particularly as both these parent laboratories provided basic standardization calibration services free as a courtesy to new members of the growing family of national standardizing laboratories.

The first ten years (1950-1960) of the standards laboratory showed little progress because of the difficulties in finding a suitable head of the department. During this period most of the engineering metrology equipment was passed over to the Standards Institution (SII) to operate on behalf of the NPLI, since the SII, being in Tel Aviv, was nearer the industrial center of gravity of the country. Some basic metrology was kept in Jerusalem and recently added to--for example the master gage-block interferometer and long gage-block comparator.

Since 1960 we have been fortunate in having an experimental physicist, Mr. Dov Pelli, to head the standards laboratory, a man really dedicated to precision measurement. Unfortunately it has been extremely difficult to find additional suitable physicists to build up a viable standards division. It has further been noted that the use made of the high quality facilities and competence, by the industrial community, has been extremely disappointing.

The double difficulty of building up and keeping a good staff and the poor use by industry has led us to take a fresh look at the whole question of precision measurements in a developing country such as Israel. We all accept, almost axiomatically, the belief that a developing nation must establish a national standards laboratory if it wishes to build a successful "high-technology" industrial base. In this paper we wish to examine--and possibly question--this fundamental belief. Has the classical concept of a national standards laboratory which sets up basic standards of length, mass, temperature, electrical measurements, etc., become inappropriate for newly developing countries?

We will first consider some data on the recent situation in the standards division of the NPLI. We have compiled statistics of the work performed by the standards division of the NPLI from January 1969 to June 1970, a period of one and one-half years. On the basis of this data certain conclusions will be drawn. However, we must point out that data are not available on work which has been refused due to a lack of capability. Thus an argument can be made that the work actually performed is not an adequate or sufficient measure of the developing needs of the nation. In our opinion, this argument, though somewhat valid, is relatively weak in light of the history of work performed.

Table 1 represents a summary of individual calibration efforts performed by the standards division between January 1969 and June 1970. Note that "Garage Work"* which was a significant part of the workload in early 1969 but which has been terminated as being inappropriate for our standards division is not included in the figures. It is extremely difficult to establish an "activity trend" on the basis of this history. Neglecting for a moment November - December 1969 and February 1970, we see that on the average two calibrations per month were performed by the standards division. Investigating in greater detail the considerable increase in activity during November - December 1969 and February 1970, we find that in February, for example, the increase was due solely to the fact that a single customer (Ministry of Defense) sent a variety of his instruments (9) for calibration; similarly for November 1969.

Table 1

Summary of Standards Activities

January 1969 - June 1970

Individual Efforts

	1969												1970						
Month	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	Total
Length (special)					1														1
Pressure																	2		2
Volume											1	2			1				4
Mass											1			3					4
Optical	1		2		1							1		1	1	1			8
Temp.	1	1	1	1			1	1			1	2							9
Mech.		"Garage Work"									2	1	1	4					8
Elect.		1		1	1	1	1	1		3	3		2	3					17
Total	2	2	3	2	3	1	2	2	0	3	8	6	3	11	2	1	2		53

* This refers to tests on site of dynamometers and other equipment used in garages in connection with the testing of automobiles.

In order to normalize the data for these "clean-up" periods by a single large agency we have, in Table 2, displayed the number of different customers per month rather than the individual efforts. We see that in this representation the averaging number of different customers per month has remained at a relatively static average of two per month, with no significant variation from this average.

Table 2

Summary of Standards Activities

January 1969 - June 1970

Customers Served

	1969												1970						
Month	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	Different Customers
Length (special)					1														1
Pressure																	2		2
Volume											1	1			1				1
Mass											1			1					2
Optical	1		2		1							1		1	1	1			6
Temp.	1	1	1	1			1	1			1	1							6
Mech.											1	1	1	2					4
Elect.		1		1	1	1	1	1		1	1		2	1					8
Total (Diff. Cust.)	2	2	3	2	3	1	2	2	0	1	2	3	3	2	2	1	2		16

Let us now try to rank the workload by technical areas. We obtain the following rating in decreasing order of activity for the foremost active areas.

Table 3

Summary of Standards Activities January 1969-June 1970

Technical Area	Individual Efforts	Customers
Electrical	17	8
Temperature	9	6
Optical	8	6
Mechanical	8	4

An evaluation of the nature of the work performed in these areas can be summarized as follows:

1. The bulk of the electrical work was done for the Ministry of Defense, Israel Aircraft Industries (IAI) and the calibration laboratory of the Technion (Hebrew Institute of Technology).

2. Nearly all of the temperature measurements were done for the universities; about half for Bar-Ilan University alone.

3. Optical work was distributed and over a relatively wide front.

4. Mechanical work was primarily for the Ministry of Defense and IAI.

5. The only conclusion which can be drawn relative to mass, volume, and pressure measurements is a general lack of activity. For

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example, the only volume work performed was for the Hebrew University. The only mass measurements were for the Ministry of Defense and Israel Aircraft Industries.

In summary, a total number of 53 individual calibrations were performed for a total of 16 different customers over a period of one and one-half years. Fully half of this total workload was performed for two customers, the Ministry of Defense and IAI.

In order to gain further insight into the need for a national basic standards laboratory, several "high precision" industrial organization and calibration laboratories were visited. When these "non-users" of the NPLI Standards Division were pressed for their reasons of non-use the response was uniformly a lack of need for external calibration services. Furthermore, these "non-users" cannot be accused of a lack of appreciation of the need for standards. The Ormat turbine, for example, represents one of the highest precision products produced in Israel. Yet Ormat has never felt the need to use the calibration services of the NPLI. Similarly Rehovoth Instruments also produces high precision components and in addition has a significant electronics capability, yet has never felt the need for NPLI calibration services.

A significantly different situation exists at IAI. IAI has established its own calibration laboratory and this laboratory regularly sends its equipment to the NPLI for calibration. This is precisely the desired relationship between a national standards laboratory and an industrial organization. However, even this ideal situation must be examined.

Equipment facilities and funds available to IAI, exceed those available to a government laboratory. For example their frequency standards are far superior to the NPLI standards and their electrical and mechanical calibration equipment is far more costly than the equipment at the NPLI. Yet they are significant users of the NPLI Standards Division,accounting for 20% of the total number of "individual efforts." Investigation of this point brought to light a specific requirement placed upon IAI by one of their foreign customers--that equipment calibrations be traceable to a recognized national standards laboratory such as the NBS, NPL, or the NPLI. They are satisfying this contractual requirement for certification in several ways. Precision general purpose electronic test equipment, for example, can generally be returned to the manufacturer who possesses "house standards" traceable to a national laboratory. Although this procedure may take three to six months the calibration cycle of laboratory equipment can be adjusted to fit this schedule. In the worst case, two sets of equipment may be required by the IAI standards laboratory; the cost of electronic calibration equipment does not make this prohibitive. (More about this point later.) In certain instances and specifically for special purpose equipment, it is more convenient for the IAI to obtain certification of the NPLI and in those cases it attempts to use the services of the NPLI. However, it is becoming increasingly easier for IAI to solve its certification problem by using its overseas offices to handle these activities. Thus, it can be expected that the NPLI will be used more and more for special purpose calibrations which the IAI standards laboratory cannot handle and which cannot be sent overseas due to the non-standard nature of the work.

What impact does this background have on plans for the future development of the NPLI Standards Division? In particular, let us first consider the need for a classical standards laboratory in today's technology. A national classical standards laboratory is (or was?) indeed mandatory, when the maintenance of these standards within industrial organizations was impractical. Thus, if a given standard was extremely difficult or very costly to maintain, then the industrial organizations could only afford to keep easier or cheaper secondary standards which would be periodically checked by a national facility. However, if both the difficulty of maintaining high precision industrial standards is significantly decreased and so also is the cost, then serious industrial organizations will have the capability of easily acquiring, within their own facilities, standards which previously had been restricted to a "national" level. It might be argued that this procedure is wasteful or inefficient, but, if the success of a given industrial organization depends upon high precision and suitable instrumentation can conveniently be acquired, then the prudent industrialists will establish an "in-house" capability rather than be dependent upon an external agency. Thus, in modern technology, the accuracy requirements placed upon a national laboratory are increased. Perhaps of even greater significance is the impact on the workload placed upon the national laboratory under these conditions. An industrial organization maintaining its own high precision standards will eventually desire to have its standards calibrated. However, since its high precision standard is used so infrequently, a long period will pass before this high precision standard is even suspect. Consequently, although the national laboratory can have a useful role to fulfill, its workload can be unacceptably low. Furthermore, coupled with this lowered workload is a requirement for a more competent staff capable of handling the increased level of precision placed upon the national laboratory. Thus, relative to the past, today we require a more highly skilled specialist staff to handle the decreasing workload emanating from serious precision industrial organizations. If the number of these "precision" organizations is relatively small, as it is in Israel, then the rational maintenance of a national facility becomes difficult. It becomes far more economical to send the precision "in-house" standards back to the manufacturer for calibration. On a purely economic basis in some cases it may even be desirable to purchase regularly new "certified" standards and relegate the high precision standards to daily use. Thus, we must realize that, although a classical national standards laboratory can play a useful role, its classical high precision workload will be extremely limited until the industrial base has increased significantly. Under these conditions the maintenance of a competent staff is nearly impossible.

In realization of this situation with respect to classical high precision work, what type of work should be performed by a national standards laboratory under Israeli conditions? We see a shift in emphasis to two distinctly different, and even opposing directions. First, increased emphasis on "emerging" precision industrial organizations. These "emerging" organizations realize that their equipment should be calibrated even though they do not demand extremely high precision. They have not reached the stage of justifying "in-house" standards and cannot conveniently deal with overseas calibration services due to time, budget, and equipment limitations. (For example, they do not have "spares" of laboratory test equipment.) Strictly speaking, in the hierarchy of the standards world, their requirements should be met at some level below the national level though perhaps, under Israeli conditions it is a perfectly legitimate function of the national facility. Note that off-the-shelf high-quality test equipment is available to perform this lower level of calibration, and special facilities or airconditioning requirements are not necessary. Nearly all of the work can be performed by skilled technicians under the supervision of one or two professionally trained people. Thus, the national standards laboratory fulfills the same function to many small organizations as does the Israel Aircraft Industries Standards Laboratory to the different laboratories of IAI.

A second class of work exists which is diametrically opposed to the above. Occasionally, as occurred recently at the NPLI, new techniques for calibration and adjustment of precision equipment will be desired. In certain processes it may be desired to make precision measurements during the course of the process; for example, the dimensions of thin and thick films in electronic component development. Another example could be techniques for measurement of laser power output in operational systems. A fundamental problem exists in attempting to maintain a standards group specializing in non-standard work. By its very nature the workload is "unplannable" and yet requires an extremely competent staff of individuals who specialize in relatively narrow fields. Thus again we are faced with a workload-manpower problem. Furthermore, individuals possessing the skills required to execute properly the work will not tolerate long periods of idleness.

One possibility we are considering is that a national standards laboratory should devote effort to the development of high-precision portable and possibly single-use fixed points for calibration and checking of in-house standards. In the same way as a relatively low cost standard cell (or better, two or three such cells) can be used to check that a high precision digital voltmeter (high input impedance type) has not wandered far from its original calibration. Other fixed points--for example, one-shot melting point standards, or pressure generators, could be developed that would be substantially free from experimental error when used in-house. If an adequate definition of several such projects could be established, then a group could evolve which could bridge the gap between the awareness of the real somewhat lower precision needs of the bulk of Israeli industry, and the capability of solving the many difficult non-standard precision problems which arise.

Another approach for attracting and keeping good scientists that is being studied is to give them the opportunity to do research, recognizing that the subject may be far removed from standards work. Herein lies a difference between large and small countries. In the NBS there is a large amount of pure research going on, yet most, if not all of it, is in some way related to standards. There are new needs, developments in industry, new technologies that require new data, new standard materials, etc. In a small country there is likely to be much less scope so that, while research subjects can be found for young scientists, they may have almost nothing to do with standards. In other words, a high precision standards activity becomes possible when one is prepared to "write-off" a part of the staff's time to activities that are not directly connected with standards.

In conclusion, we can only state that at this stage the role of a national standards laboratory in Israel has not yet been clarified. What is clear is that history has shown that a developing nation cannot merely emulate the nature of the major standards laboratories of the world. However, our analysis has led us to a difficult position. A national standards laboratory which is responsive to industrial development needs in a developing nation will operate primarily at a relatively low level in the standard hierarchy. As such it will begin to approach a "testing institution" in character and not resemble closely a classical national standards laboratory. Paradoxically, this may be a result of the technological advances which have brought a high precision capability into the factory itself. This entire issue is currently being examined in depth in Israel.

Paper 3.4 - Instrument Problems in a Developing Economy*

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1. Applied Metrology

It is needless to elaborate at this opportunity on the well-known role of measuring instrumentation as an indispensable tool to foster and to sustain development, especially industrialization. From a strictly economic point of view, industrialized countries have to apply a metrology--a very refined and careful one--in order to keep up with technological progress, to hold the impetus acquired by national industry, and particularly for testing and monitoring the quality of their products. In a developing economy, particular efforts on applied metrology are required to back any raise in existing industrialization, and this raise means all possible increase in quantity, quality, and variety of the items manufactured.

Nowhere can measuring instruments be absent, otherwise a highly developed economy would deteriorate its standing, and a less developed area would remain bound to its industrial limitations. Metrology, however, should obviously not be the same in the latter case as in the former, for the simple reason that instrumentation has to push beyond, and at the same time to fit the existing stage of advancement in the country or area concerned. Neither too much, nor too little metrology; measurements should be kept consistent with quality and price of the products involved.

Without any intent to draw sharp boundaries, rather bearing in mind recognized zones of overlapping, one could identify four fields for the application of metrology, namely: commerce, industry, technology, and science. The sophistication and the cost of measuring instrumentation grow from commercial to scientific uses of metrology, with intermediate steps at the industrial and technological levels.

Even in backward economies a minimum of metrological equipment for trade must be available to engender confidence between sellers and buyers, and to ensure correct transactions. On the other hand, research in the science of measurements is a summit task that will be effective only in well developed economies or in internationally supported institutions. Midway between these extremes, any non-industrialized area, starting with purely commercial metrology, will need more and more elaborate metrological resources, as its economic activities gradually expand into industry, technology (i.e., development of autonomous industry), and science. Diversity in metrology denotes progress in development. When reaching advanced stages of development, an industrialized economy will possess an integrated metrology, covering the four fields: commerce, industry, technology, and science.

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* Paper prepared for the NBS-AID Seminar on the Role of a National Capability in Metrology and Standardization in Industrializing Economies - Airlie House, Warrenton, Va., U.S.A., 1-5 February 1971. Not presented because of author's illness.

2. Developing Economies

Developing regions of the world very often offer the contrast of some areas with living standards which approach those of fully developed nations, and other areas that are actually underdeveloped. Within this range, various stages of development exist, and high rates of progress may be detected here and there.

Wherever industry is young, having the shape of artisanship rather than a structure for mass production, measuring instruments have to be imported and are mostly intended for commerce. The chief monitoring activity exercised on such instruments is periodic inspection and calibration, which are performed either with physical devices or with standard reference materials, according to the category of each instrument. At this initial stage, only secondary standards for basic units are necessary; they would come from abroad and would be calibrated at some national laboratory in the supplying country. Most standard reference materials should be procured from external sources as well.

At a second stage, with the growth of industry (even when based on imported know-how and burdened by royalties), some instruments will begin to be produced in the area, to serve commerce and the growing industry itself. Some kinds of these instruments will soon call for control by public authorities, entailing the concepts of approved prototypes, initial examinations, and periodic inspections. Little by little, national industry tends to replace foreign industry, and will gradually produce a series of measuring instruments and standards. For a long time, however, the more refined and accurate instruments, as well as a number of special standards, will depend on foreign supply.

3. Study of Problems

Let us now consider a selection of the problems likely to be encountered in the procurement, calibration, and maintenance of measuring instruments in a developing economy. Instrument problems of the kind which will now be referred to might occur in economies whose degree of industrialization is similar to that of some areas in Brazil right now or in recent decades. In this country, several of the study cases among those to be described here are already on the way to being resolved. Nevertheless, any experience present or past, and extrapolations suggested by factual data, will certainly serve the purpose of this Seminar, which is to explore possible links to be strengthened between industrializing economies and great national or international capabilities in metrology and standardization.

4. On Procurement

Public organizations do not always possess enough financial resources to purchase all measuring instruments required for their intended functions. This is a problem that becomes significant when duplication of functions occurs--and this has happened. The high cost of instruments will unjustifiably drain resources when these instruments are for identical purposes purchased by two public organizations operative in the same field.

It is private industry which really needs measuring instruments, and it has in fact enough budgetary resources. Paradoxically, industries do not always purchase instrumentation; why? One possible reason is that nobody endowed with technical authority has ventured to demonstrate the advantages of instrumentation; alternatively, industry people do not really believe that adequate instruments will help them to get better efficiency in production operations, and to obtain final products of improved quality at lower cost. Fortunately, in developing economies a number of industries have gone beyond this threshold.

Some industries seldom utilize existing instruments of their own, for lack of efficient maintenance, lack of trained personnel, or lack of standards. In other cases, available instrumentation remains unused because the devices have been improperly selected for the intended purpose, or are of poor quality. Both situations can result from inadequate guidance in making the purchase. In one case which actually happened, obsolete components--electronic tubes of discontinued series--were being supplied as though they were very special components!

5. On Calibration

Obvious difficulties arise from temporary lack of standard reference materials, or from the non-existence of basic standards. The first situation is particularly unfavorable for chemical industry and for any other industry that needs chemical or physico-chemical tests for the monitoring of processes or from sample testing in mass production. Such industries consume standard reference materials regularly; but for developing countries, sources of supply are generally external. The availability of working standards for measurement units depends on specialized institutes which produce and certify such standards; industry is lost when these do not exist in the country.

One serious problem to be faced is the shortage of personnel trained in techniques of instrumental measurements. Another source of trouble is the great diversity in specifications and test methods introduced by foreign firms--a diversity very often not really significant for the objectives in view.

6. On Maintenance

Scarcity of spare parts might be complicated by diversity among manufacturers and their national origins; such diversity in some areas is enormous. In this connection, a curious aspect deserves comment: a variety of instruments entails a small market for each manufacturing company; hence, it is not rewarding for the manufacturer to invest in a large stock of spare parts; lack of spare parts leads buyers to lose interest in the products of that particular manufacturer. When he gradually loses the market, then new manufacturers begin to produce a similar item, and the final result is an even greater diversity.

Bureaucracy in departments that have charge of controlling external trade, can hinder the importation of spare parts besides the ordinary difficulties in licenses, duties, currency restrictions, credits, etc. As a consequence, time and effort is wasted while instruments remain inactive for long periods. Most developing countries lie on tropical zones or have sub-tropical climates. Nevertheless, a number of manufacturers do not "tropicalize" instruments for exportation, perhaps being unaware of the destination for the equipment. However, a hot and humid environment increases the probability of failures.

Maintenance and repair require not only skilled personnel, specially trained for the job, but also blueprints, diagrams, sheets of recommendations, instruction manuals, and other aids. Absence of these basic elements makes it difficult to give prompt service. In some administrations, the laboratory has a reasonable budget for the purchase of instruments, but no adequate appropriation for maintenance. This leads to the absurd result that it becomes easier to buy a new instrument than to mend the old one which may need only a simple inexpensive repair.

7. Suggested Improvements

(a) Well equipped centers of instrumentation, at least one for each geographical area of operation, would help to attain the following goals:

- to train operators and maintenance personnel;
- to give advice regarding acquisition of instruments;
- to supply secondary standards (each center would have primary calibrated standards);
- to carry on measurements involving great responsibility;
- to operate a pilot laboratory to find solutions for special problems in applied metrology; and
- to provide an emergency maintenance service in the area.

(b) Every metrological laboratory should set up a medium-term plan for the purchase of instrumentation, with consideration of diversity, avoidance of duplication, and appropriate quality.

(c) Governments should adopt an open policy relating to the import of essential spare parts by the owner of measuring instruments.

(d) Manufacturers should exercise strict control of quality on instruments destined for foreign trade with a view to minimizing difficulties in maintenance.

(e) Extensive standardization is desirable for components commonly used in measuring equipment, in order to permit wide-ranging interchangeability of parts.

8. Desirable International Cooperation

(a) Any metrological coordinating service, either in advanced or in industrializing areas, must keep informed on the activities of the International Bureau of Weights and Measures (BIPM), on the recommendations by the International Committee of Weights and Measures, and on the resolutions of the General Conferences of Weights and Measures.

(b) International cooperation in metrology and standardization should be shaped, wherever applicable, in accordance with the guidelines approved by the UNIDO Symposium on Industrial Development (Athens, 1967).

(c) Great national institutions, experienced in metrology and standardization, should render advice and assistance to industrializing economies, under contracts or agreements which might envisage for instance: up-to-date information, revision of programs, selection of new instrumentation, advice on management problems, supplying of physical standards (both devices and materials), local expertise, specializing fellowships, and other means.

The author would like to thank Messrs. Moacir Reis, Director General, National Institute of Weights and Measures, Rio de Janeiro, A. A. Arantes and R. Borges da Silva, both from the Instituto de Pesquisas Tecnológicas, São Paulo, for helpful suggestions on topics to be included in this paper.

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Paper 3.5 - Needs for Standard Reference Materials for Calibration and Quality Control

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I. Introduction

The development and success of any highly industrialized society is based to a large extent on the mass production of goods and services. But, mass production without the strictest quality control of the means of production leads to inordinate waste of both material, labor, and ultimately to a state of extreme inefficiency of the economic system of that society. In turn, quality control implies an ever-increasing compatibility in the measurement process, the interchangability of parts, and stringent performance criteria and the control of composition for the wide variety of materials, including the starting raw materials, now required and used to produce these goods.

The key to efficient and useful quality control is meaningful measurement. Measurement involves the assignment of a value or values on a number scale to some defined property or characteristic of a body or material, and the technique by which this assignment of values is accomplished is the measuring process. The numerical result that emerges from the measurement process should be expressed in units according to an accepted system such as the units that form the basis of the Système International (SI). Thus, to a specified property of a given material, a measuring process assigns a value expressed in an accepted system of units. Measurements, to be meaningful, must fulfill two conditions:

(1) Repeated application of the measuring process gives essentially the same value, whether done in the same or in different laboratories. This property of a measuring process is called precision.

(2) The value obtained by the measuring process should be essentially the same as the value obtained by any other acceptable process that aims to measure the same property under consideration. Furthermore, this must be true of all the material under test (lots, sub-lots, sub-samples, etc.) that belong to the class covered by the measuring process. This second condition is called accuracy.

One of the principal ways in which the National Bureau of Standards assists science, technology, and industry in the achievement of meaningful measurement--and thereby quality control--is through the production, certification, and issuance of Standard Reference Materials (SRM's). NBS defines a Standard Reference Material as: a well-characterized material, produced in quantity, that calibrates a measurement system. Because SRM's are materials, they are easily transported to the site of the user, where the user himself may then perform the on-site calibration of his instrument or measuring process. In cases where SRM's are available, it is no longer necessary for the user to ship his instrument to a central standardizing laboratory for calibration. Through this process, time and money are saved and the possibility of damage to the instrument during shipping, or loss of calibration due to rough handling and the like is minimized. This on-site calibration by which the values obtained in a measurement process in

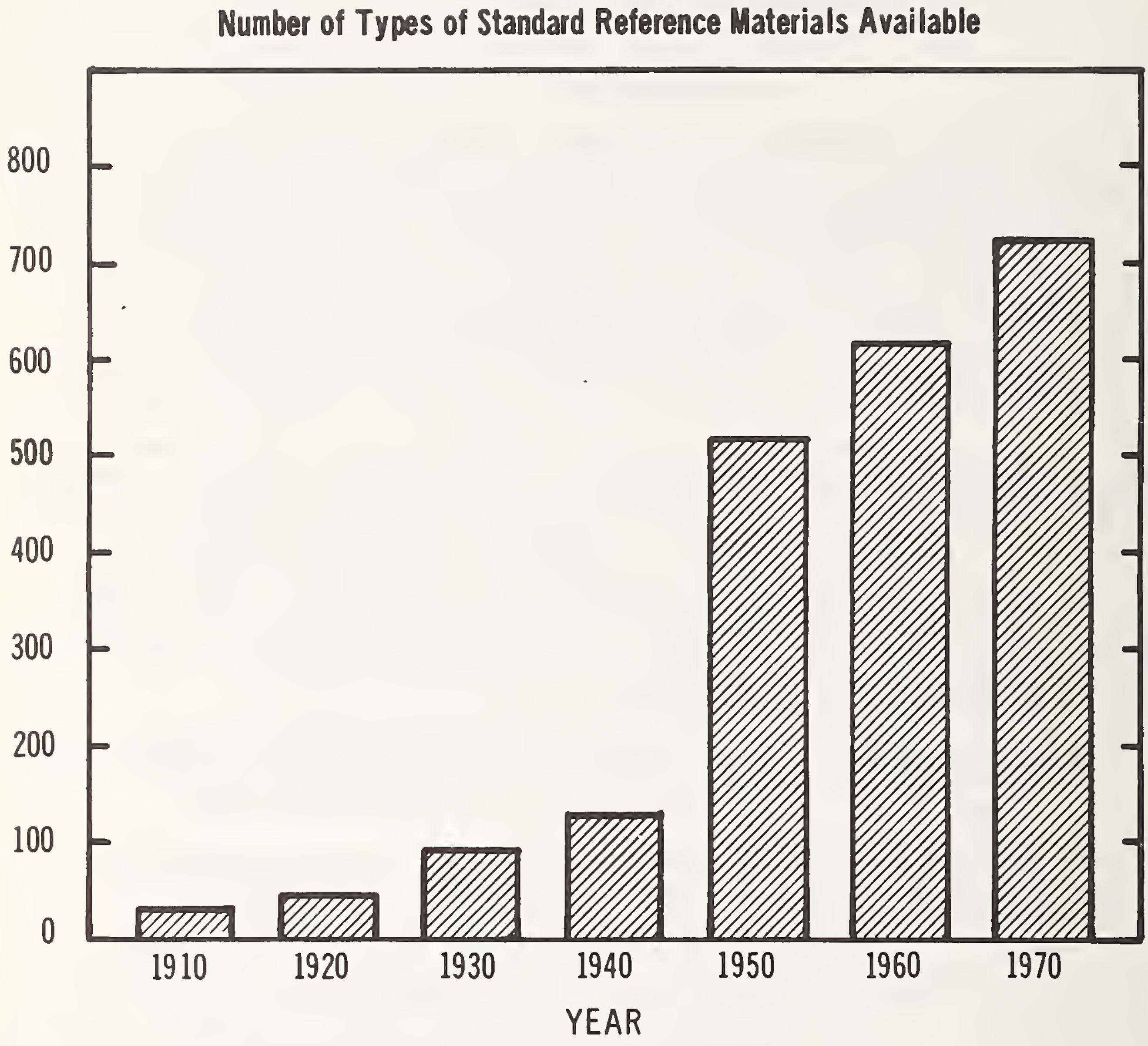
Number of Types of Standard Reference Materials Available
800
700
600
500
400
300
200
100
0
1910
1920
1930
1940
1950
1960
1970
YEAR

Figure 1

widely separated industrial plants or laboratories, or between the producer and consumer of goods or materials, may be referred to a common, widely accepted base is certainly one of the major advantages in using SRM's. Furthermore, because the properties of NBS-SRM's are measured and certified by a central national laboratory of high technical competence and impartiality, these SRM's are widely accepted, both within the United States and internationally, as primary standards with which the intercalibration and measuring process may be undertaken with confidence.

As the SRM program has developed to fill the above needs, four primary uses of SRM's have become apparent. These uses are:

(1) To provide better quality control of industrial and technological production processes;

(2) To provide a smoother, controversy-free exchange of materials and goods, both nationally and internationally;

(3) To provide a clear definition and basis of performance characteristics; and,

(4) To provide more meaningful and comprehensive measurement competence.

In the context of this Seminar, it will be useful to discuss these uses as they apply to the problems of nations whose economies are in a state of growing industrialization and this will be done in Section III, below.

In the way of a bit of history concerning the NBS-SRM program, the first SRM's were issued in 1905, shortly after NBS itself was established by an Act of Congress. These were four cast-iron "standard samples" as they were then called (the term Standard Reference Material being a relatively new descriptive phrase) used in industrial laboratories to control the quality of cast iron produced within the United States. It is interesting to note that the need and use of one of these original cast-iron SRM's is still current, and NBS has had to renew the original lot of material, long since depleted of course, twelve times in the intervening 65 years. From that modest beginning, the program has now grown (see Figure 1) until in 1970 more than 700 different SRM's are available. In the past year 33,000 units valued at 1.2 million dollars were sold to over 13,000 companies, universities, and individual users. Of this volume, almost 30% was sent to countries outside the U. S. In this country several major industries depend extensively on NBS-SRM's for the quality control of their production and processes valued in the many tens of billions of dollars. A sampling of these are shown in Figure 2.

In the remainder of this paper will be discussed:

(1) How NBS-SRM's are produced, measured, and certified;

(2) The present and future SRM inventory and how these SRM's can be used to meet the needs of industrializing countries; and,

(3) International cooperative efforts, past and present, and possibilities for the future.

SOME MAJOR U.S. INDUSTRIES USING NBS SRM's (1970)

Industry	SRM Types Available	Units Sold
Iron and Steel	179	12246
Rubber	19	2233
Ores, Ceramics	24	1105
Non-ferrous metals	98	2511
Clinical laboratories	5	548
Nuclear (power)	21	1050
Paper (tear and fading)	5	385
Cements	6	920
Metallo-organics (transportation)	26	1864
Primary Chemicals (chemical industry; science)	12	2534

Figure 2

II. The Production and Certification of NBS-SRM's

The SRM program at NBS is conducted on a non-profit, yet self-supporting, cost-recoverable basis with the full cooperation of the industrial and scientific communities. In fiscal year 1971, the direct costs associated with the program are 1.84 million dollars, although indirect costs associated with supporting research and the cooperative efforts of U. S. industry are at least twice that amount.

Before describing the steps followed in the production of an SRM, it is beneficial to describe some of the general requirements that must be met if an SRM is to be useful in fulfilling the needs listed in the Introduction. Some of these are:

(1) The SRM must possess a high degree of homogeneity, so that all portions of the material are essentially alike in all of the pertinent properties measured and certified;

(2) Consistent with its intended use, the properties of interest must have been determined with the necessary degree of precision and, usually, accuracy; and,

(3) The certificate issued with the SRM must give not only the best values for the properties certified, but also the limits of uncertainty for those values.

In many instances, the desired high accuracy, in the sense of the above definition, is impossible to achieve. This may occur for an SRM when, for reasons beyond elucidation at the time of issuance, different methods of measurement fail to give like values for some property. In this event, the certificate must clearly state by what method its certified value has been determined. The certified value then is not absolute, and refers only to that specified measuring process. As long as the user is aware of this situation, the practical usefulness of the SRM for the standardization of a test method is generally not impaired.

The six major steps involved in the production of SRM's are:

(1) Planning and Setting of Specifications -

In this planning stage the following questions are raised and answered: what properties are to be measured and certified; what limit of accuracy is required for the intended use; is material of the requisite purity, form, and composition readily available; what measurement methods are to be used to test and assure the homogeneity of the material and also to measure the properties to be certified?

(2) Material Specification and Procurement -

NBS, in general, does not make or process the materials from which SRM's are produced. U. S. industry cooperates fully in supplying special lots of high-purity or materials specially prepared to NBS specifications.

(3) Homogeneity Testing -

Typical lots of material range from several to 7000 kilograms or more. To assure that the entire lot is homogeneous throughout, especially with respect to the property or properties to be certified, extensive testing is performed. This testing, in general, relies heavily on such techniques as: optical emission and x-ray fluorescence spectrometry, and spark-source mass spectrometry. Other methods, e.g., the measurement of the residual resistivity ratio, are used where such physical properties can be used to assure homogeneity.

(4) Measurement of Properties -

It is in this area that the great skill and diversity of technical competences within NBS is used to full advantage. Physical properties measured and certified for SRM's range from micrometer-sized particle distributions, through density, viscosity, dielectric properties, and Mössbauer effect, to extremely complex property measurement, e.g., thermal emittance or specular spectral reflectance. Certification for chemical composition ranges from simple steels where only the carbon content is measured, through primary chemicals where accuracy of the order of a few parts in a hundred thousand is required, to complex clinical chemicals, such as bilirubin or cholesterol, to a very high-purity zinc where more than 20 elements are measured, some at the parts per billion (10^9) level. Fourteen technical divisions involving more than 200 distinct scientific competences, and over 300 skilled scientists all contribute to this work. Figure 3 lists a sampling of these specialities.

RESOURCES AVAILABLE FOR MEASUREMENT AND CERTIFICATION OF STANDARD REFERENCE MATERIALS

TECHNICAL DIVISION	EXAMPLES OF TECHNICAL COMPETENCES
METROLOGY	Thermal expansion; Phase transitions; Colorimetry; Photogrammetry
MECHANICS	Pressure measurements; Humidity; Vacuum techniques
HEAT	Thermodynamic properties measurements; Calorimetry--heat of combustion, fusion, solution, etc.
CRYOGENICS	Residual resistivity ratio; Low-temperature measurements
ANALYTICAL CHEMISTRY	Trace element analysis; Electrochemistry; Microchemistry; Gravimetry; Spectrophotometry
POLYMERS	Molecular weight determiniation; Dielectric properties; Viscosity
METALLURGY	Electrolysis; Metal deposition; X-Ray diffraction; Quantitative metallography
INORGANIC MATERIALS	Crystallography; Solid-state physics
PHYSICAL CHEMISTRY	NMR; Thermochemistry; Mass Spectrometry; Radiation chemistry
PRODUCT EVALUATION	Physical properties of rubbers (viscosity, stress strain)
BUILDING RESEARCH	Fire research; Materials durability and analysis
NUCLEAR RADIATION	Radioisotopes; Nuclear properties
INFORMATION PROCESSING TECHNOLOGY	Magnetic Tape Characterization
APPLIED MATHEMATICS	Statistics; Experimental design

Figure 3

(5) Certification -

In the definition of an SRM, the phrase "well-characterized" was used. An SRM is well-characterized (for those properties that are measured and certified) if the results of the measurement process are obtained by one or more of the routes shown in Figure 4. The first route is the technique preferred over the others, for, by definition, a referee or reference method is one of known accuracy, and if the SRM is thus characterized it will then be an SRM of known accuracy. The statistical evaluation is straightforward.

HOW THE ACCURACY OF AN SRM IS ESTABLISHED

1. Use reference method run independently by 2 or more analysts. (NBS)

-or-

2. Use 2 or more reliable and independent methods. (NBS) No reference method available.

-or-

3. Use inter-laboratory comparison systems. Allow several independent methods. (NBS plus cooperating laboratories)

Figure 4

The second route is used when referee or reference methods are not available. This is often the case where new state-of-the-art (e.g., very high purity metals) SRM's are to be certified. Note the word "reliable" in reference to the analytical method. A reliable method is one of high precision, but the systematic biases of which have not been fully established. Inaccuracies of such methods are usually estimated by the investigator, and must be small relative to the accuracy requirement or goal set for the SRM being characterized. Statistical evaluation here is difficult, and, at times, a certain subjective weighing of the inaccuracy statement must be allowed. In such instances at NBS, a very conservative approach is followed.

The third route is used when many methods of analysis are available and each cooperating laboratory, for pragmatic reasons that need not be discussed here, wants to use its own method of choice. Strictly speaking, no statistical evaluation of accuracy can be done, as the inaccuracy of any given method is not usually stated and each result is from a somewhat different measurement universe. This route has validity because of the overwhelming weight of evidence based on a thorough knowledge of the competence of the participating scientists and laboratories. Obviously, highly accurate SRM's cannot be and are not certified by this route, but a large number of industrial SRM's, where accuracy considerations are not highly rigorous, are thus characterized.

Based then on the above measurement and statistical evaluation, a Certificate or Certificate of Analysis is issued by NBS that becomes an integral part of the SRM issued.

(6) Distribution -

Through the NBS Office of Standard Reference Materials (OSRM) all SRM's produced and certified by NBS are distributed throughout the U. S. and to other countries of the world. The OSRM maintains the SRM inventory and issues a catalog and price list (ref. 1) that describes each of the 718 SRM's presently available. The OSRM technical staff is always available to answer inquiries concerning the availability and use of SRM's and, in addition, gathers data and information concerning the need for renewal and new SRM's.

III. The Availability of SRM's to Meet Needs in Industrializing Economies

While it is true that many of the SRM's were produced and issued by NBS to meet the needs of the highly technological economy of the United States, it is also a fact that many of them will have immediate utility in some regard to meet the needs of countries whose economies are now in varying degrees of technical sophistication. In the introductory section four principal uses of SRM's were pointed out. In any economy where the mass production of goods is underway or being planned, the quality control of the means of production and the goods produced must always be a prime consideration. As is evident from the previous discussion, SRM's provide one mechanism for achieving this goal.

The trade of materials and goods between nations is the very essence of economic growth and well-being. SRM's provide the mechanism whereby both buyer and seller can be assured that specifications--be they of raw materials, such as ores, cements, minerals, and the like, or intermediate processed materials, e.g., pig or cast iron, raw rubber or chemicals, or finished or high-technology materials, e.g., glass, high-alloy metals, measuring instruments, etc.--can be measured with a sufficient degree of accuracy, and thereby with assurance, so that equity on both sides prevails. Furthermore, customs duties and various tariffs on raw materials are usually assessed on the content of one or more of the chemical constituents of the material being traded, and it certainly is in the interest of both exporter and importer to know the true value of the composition with as much assurance as possible. SRM's are invaluable in this regard.

Performance characteristics, especially of sophisticated instruments and measuring devices, should be based on SRM's whenever available. The accuracy of clinical measuring systems can now be checked using NBS-clinical SRM's in procedures to test both the accuracy and precision of the system to see if the manufacturer's claims are warranted and valid. Other SRM's to check basic metrology instruments, e.g., spectrophotometers, balances, calorimeters, and a wide variety of instruments now essential to developing technological economies, are also available.

Finally, SRM's introduced and used in a consistent manner in any measuring process tend to increase, over a period of time, the accuracy and precision of the measurements themselves, and perhaps more importantly, they increase the competences of the scientist and raise his self-assurance through the knowledge that he has available to him a source of material through which errors are immediately exposed, thereby allowing immediate remedial action on his part. This action-reaction time must be short if inefficiency and waste are to be eliminated in the measurement process upon which a large part of all industrial technology depends.

In the table that follows, the presently available NBS-SRM inventory has been categorized under several major headings, all of which are important in one way or another to nations whose economies are now moving toward increased industrialization.

Table 1. NBS-SRM's Available to Meet Needs in Industrializing Economies

Category	NBS-SRM's Available	Examples
A. Raw Materials		
ores	10	iron, tin, zinc, uranium ores
cements	6	Portland cements
minerals	6	limestone, feldspar, clays
refractories	5	chrome, silica
sugars	6	sucrose, dextrose
B. Basic Industries (compositional SRM's)		
ferrous metals	191	basic cast iron and steels to high-temperature alloys
non-ferrous metals	101	copper, zinc, lead alloys
glass	14	lead-barium, opal, trace elements
rubber	19	natural, butyl-, styrene-butadiene rubbers, rubber compounding materials
transportation	25	metallo-organics for preventive maintenance procedure
chemical	60	plastics (polymers), inorganic, organics, pH, isotopes
nuclear	75	uranium fuels, radioisotopes
C. Metrology SRM's		
mechanics	82	metal coating thickness, density, viscosity, particle size
heat	20	calorimetry, vapor pressure, differential thermal analysis
optical and color	76	phosphors, charts for color matching, paint pigments
D. Health Related		
clinical	7	urea, cholesterol, bilirubin
botanical	4	orchard leaves, alfalfa
E. Pollution Control		
air	16	hydrocarbons, sulfur dioxide, sulfur in oil
F. Direct Instrument Calibration	33	Mössbauer spectrometer, electron microprobe, spectrophotometer, resolving power of cameras

All of the above SRM's are fully described in latest Catalog of Standard Reference Materials (ref. 1).

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IV. Future Needs for SRM's

In the past five to six years, the NBS-SRM program has expanded six-fold in an attempt to anticipate future needs for SRM's, particularly in fields related to areas of national concern, with special emphasis on health and environmental needs. These are, of course, world-wide issues, and indeed, industrializing societies have the opportunity to benefit from the mistakes of present highly industrialized societies, especially with regard to maintaining the integrity of the environment and its ecological balance.

NBS is now fully committed to a program to provide SRM's to increase the accuracy of results obtained in our nation's clinical laboratories. SRM's are now available to control clinical measuring procedures for cholesterol, urea, uric acid, creatinine, glucose, calcium, and bilirubin. Soon to be available are SRM's for sodium, potassium, lithium, cortisol, and VMA; more will follow these. Glass and solution SRM's to calibrate accurately spectrophotometers now widely used in the clinical laboratory are well underway. NBS is also working actively with the pertinent professional societies to develop clinical referee methods, procedures of known and proven accuracy, against which other clinical procedures for that specific analysis may be tested to assess their systematic bias (or errors), and thereby allow corrections or modifications to be made. Better health care for all peoples should result; and industrializing nations are urged to participate, to as great an extent as feasible, in this program.

Although NBS does not have the direct responsibility within the framework of U. S. agencies for restoring the quality of this nation's environment, because of NBS expertise and long history in solving problems related to the measurement process, NBS is heavily involved in providing SRM's--among other activities--so that the measurement of air and water quality may be accurately accomplished. SRM's to calibrate instruments and procedures for the determination of hydrocarbons, sulfur dioxide, sulfur in fuel oils, and carbon monoxide are now available. Now under investigation are SRM's for sulfur in coal, nitrogen oxides, polycyclic aromatic compounds, and trace elements, e.g., mercury, lead, and chromium, in both air and water.

Other areas of interest include oceanography, bio-medicine and botany, and agriculture. In view of the importance of agriculture to emergent technological societies, it should be pointed out that within a year or so, NBS will make available a series of botanical SRM's of orchard leaves, citrus leaves, alfalfa, tomato leaves, pine needles, and aspen chips. These are to be certified for the major elements, e.g., nitrogen, phosphorous, potassium, and many minor elements, now known to be important for good crop yields and healthy plants.

V. International SRM Cooperative Efforts

Traditionally, cooperative efforts between those nations having substantial SRM programs have been carried out very informally, usually on a scientist to scientist basis. In 1969, the first International SRM Symposium was held in Gaithersburg, co-sponsored by NBS and the International Committee of Weights and Measures (CIPM). A synopsis of the results of this conference is available (ref. 2). No full version of the proceedings was published. The principal recommendation of the conference was to ask the CIPM to establish under an international umbrella a mechanism to:

(1) gather information concerning the availability of SRM's;

(2) disseminate this information to all nations making inquiry;

(3) establish the needs and priorities for new SRM's; and

(4) investigate the feasibility and, if possible, establish an international mechanism for the cooperative production and certification of needed SRM's.

Unfortunately, the CIPM has unofficially reached the conclusion that such an extensive program is not now feasible without additional financial support from the member nations, and, further, that such support is not forthcoming at this time. However, the CIPM has encouraged member nations, through their national laboratories primarily, to embark on multilateral cooperative efforts, especially with regards to SRM's of basic metrological importance (e.g., a well characterized platinum for the realization of the candela).

In the meantime, realizing that the above-mentioned effort spoke not at all to the problem of SRM's for direct industrial use, NBS has embarked on a small program of bilateral efforts with two countries and one international organization to see if an effective cooperative program might yet be established. Since these efforts are still in the negotiating stages, further details cannot be given at this time.

Another mechanism whereby international efforts are possible is through the Special Foreign Currency Program (the so-called PL-480 Program). NBS has several specific projects underway in India, Israel, and Pakistan. Others are planned for Yugoslavia, and, possibly, Poland. Among the current projects are:

(1) The preparation and production of ferro-alloys;

(2) The analysis of NBS-SRM's containing trace elements;

(3) The use of nuclear analytical methods for characterizing NBS-SRM's; and

(4) The preparative separation of optical isomers.

NBS through its Office of Standard Reference Materials is willing to explore with the other nations of the world, and especially with those in attendance at this Seminar, how we may cooperate and work together to bring into existence additional SRM's useful to all.

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Discussion

Co-chairmen: Phi Minh Tam and Lawrence M. Kushner

Question to Mr. Cali:

Were they soil samples that you showed us?

Mr. Cali:

No, they are actually ground-up leaves, chips from bark, or pine needles. We set aside an orchard that was grown under controlled conditions and the leaves were carefully hand picked off the trees and then dried and ground up. More and more agriculturists are moving into the automated analytical systems such as I discussed. In order to calibrate accurately the instrument and the method as a total system, it is important to have typical material in order that the method be validated. What we certify is the chemical composition. The orchard leaf has 2.76% nitrogen ± 0.02, calcium 2.09 ± 0.03, potassium 1.47 ± 0.03 and is certified for 5 other minor and trace constituents. We know that trace elements are extremely important in disease resistance. Zinc is needed for healthy pears, for example.

Dr. Probine:

I support in general terms the remarks made by Dr. Tabor. It is well known that as the accuracy of measurement is pushed higher, so too are the difficulty and cost of making the measurement. I recall that in 1953 a committee which was reevaluating the functions and responsibilities of NBS concluded that it is not sufficient to have fairly good standards measurements, fairly good methods of testing materials, mechanisms or structures, or reasonably good determinations of important physical constants. The standards, the measurements, the test procedures must be the very best, the most accurate, the most reliable that can possibly be achieved at any given time, limited only by the state-of-the-art at that time. It is thus more than a play on words to say that the standards by which NBS is judged must be the very highest there are. Now, I am sure that while we all agree that this would be a worthy goal and one which we would like to see the NBS attain, I think we must also recognize that in less developed countries there is a limit to the resources which can be allocated to this or any other field of science. No matter how laudable it might be to strive for perfection, it may be necessary in the interest of common sense and best utilization of resources to stop short of what can conceivably be achieved. This is certainly the policy we adopted in New Zealand, with a population of only 2.8 million people and a government science budget of 28 million dollars. We must adopt the policy of allocating priorities to research expenditure. Therefore, we attempt to insure that our standards are adequate to meet the needs of science and technology in the country at any given time, but we do not attempt to push our measurement capability to the limit of the state-of-the-art at that time. We leave this to bigger and more highly industrialized countries, and we conserve our resources for activities in other fields which are of special relevance to our country's needs. Precision measurement is therefore regarded as a means to an end, and not an end in itself. I am not indicating that there should not be a national standardizing laboratory. Our own laboratory does thousands of measurements a year for industry and for science. All I am saying is that in our situation, there is no need to press on to the ultimate. You tailor what you do to the needs of the country, but there still is a very definite need for such a measurement facility in a smaller country.

Mr. Felleke:

I would like to commend Mr. Hayes for his emphasis on measurement controls. You see, the situation with less developed countries is that industrialization is a new feature in the development effort. Industry might be functioning on a modern basis, or it might be working with obsolete equipment, yet it is the demands of industries that dictate the nature of the laboratories which should be maintained and serviced by the government. My question would be whether the establishment of a metrology capability in the laboratory should be examined in the light of an existing industrial development plan, or should consider the needs of the future.

Mr. Hayes:

I reflect Dr. Tabor's comments here. I was trying to focus attention on the fact that I feel that you should extend your measurement capabilities only to the extent of your need. For one particular economy it may be only a tape measure for the next five years. However, I think the needs should also reflect the planning for future industrialization. This does not mean you are going to have to have your own national metrology laboratory capable of performing the standardizing functions for everything. I do believe there should be some centralized organization capable of providing metrology engineering services; perhaps they do not even have to calibrate anything, but they should tell others how to measure or how to test. They are logistic support centers which receive standard reference materials from another country, and then there is a distribution point which can pass these along to industry, together with a selection of measurement information and documentation telling measurements people where to obtain more. This is the concept on which I believe Navy metrology is centered. We do not actually calibrate and we do not actually perform standardization in my particular organization. We evaluate methods and equipment, and then our job is to transmit information, to set up logistic schemes so that others can use them for the needs of their particular systems. These schemes vary all the way from automotive systems used in the motor pools of the Navy to the most sophisticated self-landing aircraft that may be under development. Now I believe that it is possible for a reasonably low cost, to have people for this purpose. Dr. Tabor, I would like to ask you, is there a strong feeling of national pride in your own national standardizing laboratory?

Dr. Tabor:

No, the problem that we have is not related to national pride, but I now have to face the psychological problems of the people involved. In fact, one of my best section chiefs has written a paper saying that he should go on doing what he has been doing, because he cannot get out of this way of thinking. I think the question of how to use instruments is important. We had a classical case of the industry that uses the best gage blocks in the country. We tested them once, and we found they had forgotten that if you have a scratch in a gage block, it has a burr on it. Then when you put the blocks together you simply transfer the inaccuracy through the whole assembly. Therefore, our function was to teach the people how to use the blocks, and that was more important than actually checking the length of the block. It was cheaper really to throw the blocks out after two years and buy another set. I would like to teach people how to use instruments, or even help them to buy the right instruments.

Mr. Woodington:

I have been hearing "quality control" being used in several presentations here. For the quality control process, are we really interested in absolute accurate measurement, or merely in deviation from a norm? In other words, perhaps measurements should be designed to detect a change, even though it may start from some particular value which is not even known. I would like to hear comments on that.

Mr. Hayes:

In the design or the product evaluation stage, one could use existing measuring instruments to ascertain the characteristics of the product in relation to what was wanted. For that, relative measurements may be adequate; that is, without referring your measuring instruments to a common national reference. However, if there is to be some relation between the product as it comes off the line and the product that was developed in the laboratory, the measurements made six months earlier must themselves be related to basic references. If, however, the final product works and you measure it and use that as your reference, then I would say your final product is the basic reference to which you are going to compare succeeding products. Then you have a valid gage standard to which to refer.

Mr. Woodington:

Well, I submit that the standard reference material program is based on the fact that the user is able to detect a change. The standard reference material could be in error; who cares as long as everybody uses the same standard reference material? You would still have a quality control system because you started from a given point, and from then on you were detecting a change from that point. Sensitivity in the measuring system is more important to you than accuracy.

Mr. Cali:

There are some standard reference materials which are as absolutely accurate as we can make them. Among standards for metrology, I think of benzoic acid, whose calorimetric value is known absolutely, and provides then the accurate transfer of that measurement from one laboratory to another. On the other hand, rubber being such a messy material, it is impossible to put the rubber standard on an absolute basis, and therefore, all the measurements made in the rubber industry are relative. We have intermediate cases also so that SRM's really span the entire spectrum.

Mr. Woodington:

What I am really leading up to is the suggestion that the less developed countries examine their situation to see whether they are really interested in accuracy to control their quality, or whether all they really want to know is whether they can build the same thing over and over again. If they merely need to detect deviation from whatever they started with, they might find that the cost of doing this is considerably less.

Mr. Cali:

Eventually, though, I think we have to say that accuracy is absolutely essential. For example, the automatic analyzers now used in clinical chemistry are very precise machines, and the methods are very precise. The only trouble is that practically no analytical system being used in clinical chemistry today has ever been studied for its systematic biases. That is not a great practical problem at this stage because the normal range of values in the human population is rather wide. As medicine begins to become more scientific, especially in preventive medicine where you are interested in very small changes in many interacting constituents within the human chemical factory, it is going to be important to know absolute numbers.

Dr. Rowen:

Standard reference materials for clinical medical laboratories in the USA which use automated analyzers, and the laboratories themselves, are now coming under federal license due to the Clinical Laboratory Improvement Act of 1967. These laboratories may be called upon to perform analyses for over a hundred different substances. I believe you mentioned that seven materials are now available. What are the determining factors that influence the future availability of other materials? And would you comment on how you chose the first seven?

Mr. Cali:

Let me answer your last question first. At the NBS we try not to set priorities for an industry. We ask the industry to set their priorities and then we use those as our guideline. In this instance the standards committees of the American Association for Clinical Chemists and the College of American Pathologists set the priority in which certain standard reference materials were needed.

To answer the other part of your question, we are hoping within the next two years to be in a position to control the 21 most important clinical tests. Then we will pick off some of the harder ones. Serum albumin is going to involve competences that are not now available at the NBS, and there is some question whether the health agency which is helping to support this program will fund us to go into that area. So there will be many things that we just will not be able to do.

Dr. Rohatgi:

Dr. Condon remarked that at the recent UNIDO Conference the universities were not considered as instruments of change. Let me talk about the institutions which produce technical people for industrialization. They are different from agricultural types. In this country and in Western Europe, these institutes have had considerable time in which to evolve according to the needs. What has happened in less developed countries? All of a sudden a country decides to set up an institute which is like Oxford, Cambridge, Harvard, or MIT without looking at the needs. This is why there is a mismatch between the needs of the country and what the university is doing.

Another unfortunate feature is that the lack of coupling between universities and a country's economy increases with underdevelopment. I am told that 50 years ago hardly any industry in the USA would hire an industrial consultant from a university. It is only as industry has progressed that it has hired academic consultants. At the Indian Institute of Technology we found that it was only the most advanced Indian industries that called on us for help.

When we aim to set up one of the finest educational institutions in the world, this policy puts much pressure on the faculty. They have no time to look at the local problems. Professors at IIT, Kanpur, have a dilemma: Should they stay at the Institute in the summer and write a paper for the international journals, or should they go out and solve important local problems?

Mr. Russek:

I will speak from an industry standpoint on the matter which Mr. Woodington brought up as to whether you should emphasize accuracy or deviation from a norm. Deviation from the norm is a statistical tool used in error analysis and quality control applications. This is analogous to the precision that Mr. Cali talked about. You have to have accuracy to establish what the norm was before deviation from the norm has meaning.

Dr. Astin:

I would like to come back to the question raised initially by Dr. Tabor. I think it is a very fundamental one and I do not believe it has been adequately resolved. What should be the capabilities of the less developed nations for maintaining and providing calibration services with respect to the basic standards? I think it is completely unnecessary, even ridiculous, for all of the nations of the world to try to acquire such capabilities. I would guess that the number of nations that have a capability for reproducing the basic standards of the international system of units to nearly the highest attainable accuracy is certainly fewer than ten, probably no more than half a dozen, but I think this is sufficient for the world's needs. Fortunately, we have an international organization, the International Bureau of Weights and Measures (BIPM), set up under the terms of the Treaty of the Meter of 1875, which can provide very high accuracy calibration services for nations that require them. As long as the service is available, either through the framework of BIPM or through bilateral arrangements with some of the countries that have the capability, it is in my judgment just a waste of manpower and effort to try to set up these extremely precise and accurate calibration capabilities with respect to the basic standards. I would very much like to see BIPM provide services to the less developed nations with respect to fundamental calibrations, which they all need to some degree of accuracy. I would think that BIPM might become more effective in providing such services if less developed nations sent requests there rather than trying to establish their own capability.

Mr. Peiser:

Paul Cali has shown that he is selling SRM's to the world. Are you satisfying the world's quantitative demand? Are you collaborating to the extent that you want to collaborate with outside laboratories, both in the U.S. and abroad, in trying to find an agreed evaluation of your characterizations? I have the impression that if some of the best university laboratories did collaborate with you, this would help these universities to reach a standard of excellence in certain techniques of analytical and physical property measurements. It would show them how this is related to industrial control and might bring the professor out of his ivory tower. Even in underdeveloped countries these standard reference materials are doing a useful job, and this aspect of the work of NBS is known well in all countries of the world that I have ever visited.

Mr. Cali:

We have people complaining about the cost of SRM's. I tried to show that the certification of complex SRM's is a very expensive process. We are now trying to convince the Congress that this program should be subsidized. It is in the public interest to do so, especially as we move into matters of health and pollution and the like.

Your second question relative to collaboration, I think is much more interesting. I wish I could have explored it in depth as I went through the talk. In the world of science today, more and more black boxes are being invented--very complicated, very difficult to calibrate in terms of absolute accuracy. In our compositional standards we turn invariably to the old tried and true methods of as much as fifty years ago. Now in many of the universities in developing countries, quantitative chemistry is still being taught the way I learned quantitative chemistry, with a beaker, a pipet, and a buret. In the many years that these old methods have been used, systematic errors have been investigated and worked out to a very large degree, so that if you want to certify the composition of that piece of paper I would recommend that you use the old methods. Now, at NBS we are running out of this type of competence. It is not glamorous any more; our young scientists like to turn to very complicated ways of making an analysis. The less developed countries would certainly be welcome in investigating with me and NBS the possibility of collaborative efforts on SRM's that are needed in the less developed countries, more than in the USA. I would welcome that collaboration.

Dr. Rowen:

Dr. Tabor has indicated a new approach to the problem of standardization for newly developing countries. Does he see some possible cooperative program between them and the larger laboratories like NBS or the NPL at Teddington, England?

Dr. Tabor:

I am sorry I cannot answer the question. I would say that there are some areas, such as black boxes, where I think that our needs are no different from anybody else's. If you can make a spot check to assure that the black box is doing what it did when you bought it, this is a very valuable thing. It is what the SRM's do for the composition of materials. I do not know if you have standard viscosity materials, but to try to calibrate a viscometer by any other means than by using a standard material is murder, and yet a standard material is a very rapid method of doing it. I could imagine that there are other areas where you could develop spot checks, for example, in the measurement of pressure. Today you have to use something like a piston gauge. Not everybody has an accurate one. Besides, they wear out and there is a big argument as to the real dimension of the piston. Now if you can just give a man a little device which is used only once, he can put it on the machine to generate a standard pressure and then he throws it away. If he used it a second time he might be in trouble. I believe these spot checks should be developed for a range of instruments and it would not make any difference whether it were done in a small laboratory or a large laboratory. They would be equally useful in large countries as in small countries.

Dr. Kushner:

I would like to tell Dr. Tabor that I endorse his plea for sanity and realism in defining the metrological requirements of the less developed countries. There is no point in paying for more than one really needs. I am also delighted with your story concerning the demonstrated inadequacy of the traditional methods of providing calibration services, and I am certainly pleased with your endorsement of the concept of calibration and measurement control through SRM's and similar devices. But now, as a physical chemist who has become a metrologist, to a physicist who has become a metrologist, I will put a question: Do you happen to have any independent evidence that the laboratories that were not using the services offered by your laboratory could in fact make the measurements as well as they thought they were doing?

Dr. Tabor:

Probably the best answer, as to so many questions is, yes and no. I think there are some measurements which these industrial laboratories could make quite well because they had good equipment and their people may have been trained in the use of such equipment abroad. Looking at it objectively it does not make any difference whether their spiritual guidance came from us or whether it came from Washington or Teddington. In that sense, I am really not worried. One of the things that is mentioned in my paper is the question of accuracy at much lower levels. In an underdeveloped economy you have people who are just starting up small factories and workshops and they are just beginning to reach the stage where they ought to know something about measurement. They might not even have a micrometer but they have go/no-go gauges, and somebody has to guide them in the use and the checking of these gauges. Now, in a highly developed country this would not be the responsibility of the national laboratories; it would be the responsibility of somebody in between. However, it may be that in a developing country the national laboratory has no alternative but to reach much lower down the chain of standardization measurements and help these people out. I think this is one of the things that we have to do in our country.

Mr. Hayes:

It is hard to find very much "how to" documentation in the USA on calibrating gauges, for example. The most important point of measurement is at the lowest level, and we have not properly communicated to whoever is making the measurements there; it is usually a technician. I think that is where all the careful work of the NBS and the other standardizing laboratories of the nation go down the drain.

Dr. Probine:

Concerning the way in which measurements are transmitted from the national standardizing laboratory to industry, it is my personal opinion that this has been done most successfully in Australia, through an organization called the National Association of Testing Authorities (NATA). This is an organization that runs a voluntary registration scheme for testing laboratories. Briefly the idea behind the services which NATA provides is that firms or institutions who are capable and willing to undertake calibration work are first examined by assessors chosen for their knowledge of the field, to see whether the firm has appropriate equipment, whether it is installed in suitable premises, and whether the operators are experienced in measurement and in reporting the results of the measurement. If these and other conditions are fulfilled, then the laboratory will be registered as a NATA-approved laboratory in the measurement field in which it has the necessary skills. It has the right to use a standard mark on its test reports, which guarantees to the industrial user of the service that calibrations have been carried out by a laboratory which has been judged to be competent in this particular field.

I think the system has a number of very significant advantages. First of all, the standards on which the firm relies for its calibrations are checked regularly in such a way that the calibrations can be traced back to the national standard. I think Australian industry benefits from the improvement which has taken place in laboratory practice, and from the better testing which has led to better quality control and high quality products. NATA-endorsed documents have become a reliable basis for purchasers acceptance of suppliers' test results. This avoids unnecessary duplication of test work and speeds acceptance of goods supplied under contract. It also conserves scientific and technical manpower. NATA assessment and reassessment provides management with an independent measure of laboratory performance.

NATA provides a necessary and important link between those who have the responsibility for the custody, maintenance, and development of national standards, and those who need to make accurate and reproducible measurements in industry. There are about 750 registered laboratories in Australia, 550 of which are industrial laboratories. In a country the size of Australia, the existence of 550 industrial laboratories of known competence is a tremendous resource of measurement skill.

In New Zealand we are hoping to set up a similar organization to be called the National Association of Registered Laboratories and we hope to follow the same standards of assessment and reassessment as NATA. It has been agreed with NATA that, providing we do it in this way, the two organizations will grant each other reciprocal recognition. This will mean that so far as Australia and New Zealand are concerned, for tests carried out in the registered laboratories within the two countries, we will know exactly what this means in terms of measurement capabilities. Many discussions have gone on and we have had Mr. Monahan, the Registrar of NATA, across to New Zealand. The scheme has tremendous industrial support in New Zealand and we are hoping to put through an empowering act in the next session of our Parliament. I thought I would mention this because it seemed to be relevant to the remark which Dr. Branscomb made this morning, that it was not only necessary to have good instruments, good secondary standards, but it was also necessary to insure that they were well and competently used.

Mr. Lovejoy:

As a former metrologist in Canada, which some people have called the richest less developed country in the world, I must comment that there is a certain lack of industrial research going on there for very good and well known reasons. It is probably true that the government sponsored institute, the National Research Council, is motivated by the idea of having somewhere in Canada, active research in progress. We also have UNDP programs in Canada supporting various kinds of scientific technical institutions--textile research institutes, metrology centers, standards testing centers, high voltage testing centers, and so on. Perhaps we need to find out the correct way of getting one's foot in the door in a developing country to provide a core of useful technical competence. Maybe it is better to have something, even if it is somewhat irrelevant, than nothing at all.

Paper 4.1 - Overview - The Role of Federal Information Activities

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1. Introduction

The role of federal information activities covers a broad area and is somewhat difficult to define because information has meaning only in the context of its utility and the audience for whom it is intended. Briefly put, the role of the federal information activities is to support the mission and program responsibilities of the agencies themselves. Although the information products and services they produce are tailored to the mission needs of the agencies, these same information resources are also made available to the general scientific and technological communities. With the expenditures of U.S. Government research and development programs in excess of $15 billion a year, there is a large volume of information and data being produced and being made available. The U.S. Government desires to share this valuable resource which is in reality the final product of its research and development efforts. This morning I hope to clarify the availability of this resource. In the course of our discussions we shall:

(i) touch briefly upon the role of the two main branches of the Government--legislative and executive--in the dissemination of information;

(ii) examine briefly how one obtains information about sources of information;

(iii) present an idea of the various media used by the federal agencies for the processing, announcement, and dissemination of information;

(iv) identify the principal sales outlets; and

(v) examine the dissemination of two special classes of data.

2. Role of the Legislative and Executive Branches

Let us begin our discussions by reviewing the roles of the two large branches of the Federal Government here in the United States--the legislative and the executive branches.

A. Legislative Branch

The Legislative Branch originates enactments covering the information area. Among the first such legislation was that contained in the Act of Congress of May 15, 1862, establishing the Department of Agriculture. The Department was directed by law "to acquire and diffuse useful information on agricultural subjects in the most general and comprehensive sense." Perhaps a unique information activity concerning information related to science stems from the National Science Foundation Act of 1950. Two other examples of specific provisions for federal agency responsibility for release of information are contained in the Atomic Energy Act of 1954, as amended, and the National Aeronautics and Space Act of 1958, as amended.

Both of these provide specific responsibilities for the dissemination of information.

I have cited these examples to illustrate the interest and concern of our Congress in the dissemination of the results of the U.S. Government research and development programs. I should point out again, however, that as a matter of both policy and practice, all U.S. Government agencies make available to the public this type of information--even though there may not be a statutory requirement in the agencies' enabling legislation.

B. Executive Branch

Within the Executive Branch of the Government, decision on national policies that govern the release and dissemination of information ultimately rests with the President. He is assisted and advised by members of his staff, which include the various directors of the Executive Office of the President, by the members of the Cabinet, heads of agencies, and by such committees, commissions, task forces, and working groups as may be needed either on a continuing or an ad hoc basis. An area of interest to this Seminar, namely, scientific and technical information, will be illustrative of the policy area activities.

Responsibility for advising and assisting the President on matters of national policy in the area of scientific and technical information rests with the Director of the Office of Science and Technology who is also the President's Science Advisor. This Office was created in 1962 by President Kennedy and is part of the Executive Office of the President. Under the Director of the Office of Science and Technology are several instruments for formulating and recommending policy. Among these are the Federal Council for Science and Technology more commonly referred to as the Federal Council, and its Committee on Scientific and Technical Information which is known as COSATI.

The membership of the Federal Council is made up principally of heads of the federal agencies. The role of the Federal Council is to determine the state or "health" of specific areas of science and technology--primarily through specific studies--and to recommend programs or courses of action in those areas where redirected, additional or new effort is required. After agreement is reached by the Council, recommendations are made on which agency, or agencies, shall undertake the efforts and which shall provide or share the funding support of the work effort.

Under the Federal Council, COSATI is given responsibility within its charter for:

(i) development among the federal agencies of a coordinated scientific and technical information system with the objective of improved federal and national systems for handling scientific and technical information;

(ii) review of the adequacy and scope of present scientific and technical information programs of the federal agencies; and

(iii) recommending management policies to improve the quality and vigor of the information activities of the agencies.

My purpose for mentioning the Federal Council and COSATI is merely to show that at the level of the Office of the President there is deep and genuine concern with the information dissemination activities of the Federal Government. With this background now let us briefly examine how one obtains information about the information resources.

3. Information about Sources of Information

If a person had no knowledge about federal information programs and wished to find out the sources of information in the United States, the first place he could go would be to the National Referral Center for Science and Technology of the Library of Congress. The Center was established in 1962, with the support of the National Science Foundation, and given the responsibility for identifying all significant information resources in the fields of science and technology; acquiring data describing the specialized capabilities of these resources; and providing guidance about their use.

It could be described as the "information desk" of the scientific and technical community. It does not provide technical details in answer to inquiries nor does it furnish bibliographic assistance. It functions rather as an intermediary, directing those who have questions concerning scientific and technical subjects to organizations or individuals who have specialized knowledge in these fields and are willing to share this knowledge with others.

In answer to requests for guidance and assistance, the Center provides names, addresses, telephone numbers, and brief descriptions of appropriate information resources. "Information resources" has been defined broadly so as to include professional societies, university research bureaus and institutes, federal and state agencies, industrial laboratories, museum specimen collections, testing stations, and individual experts as well as more traditional sources of information such as document centers, and abstracting and indexing services.

Referral services are available without charge. No special forms are required. Requests may be made by calling on the telephone (area code 202, 967-8265), by writing to the National Referral Center for Science and Technology, Library of Congress, Washington, D. C. 20540, or by visiting the Center on the fifth floor of the Library of Congress Annex, Second Street and Independence Avenue, S.E., Washington, D. C.

An example of the products of the National Referral Center is "A Directory of Information Resources in the United States" which is available from the Superintendent of Documents, U. S. Government Printing Office (GPO), Washington, D. C. 20402, as LC 1.31:D62-1967. In this Directory are represented all appropriate federal information resources, as well as information resources sponsored in whole or part by the Federal Government. It describes the areas of interest of the information resource, its holdings, types of information resources, addresses and phone numbers.

A second example of information about information sources is the "Directory of Federally Supported Information Analysis Centers" prepared under the auspices of COSATI. Incidentally, the COSATI panel that prepared this directory is chaired by Dr. Edward Brady of NBS, who is here with us. It is available from the National Technical Information Service, Springfield, Va. 22151 as PB 189300; so are many other such directories.

An information analysis center is a special type of information center. It is a formally structured organizational unit specifically established for the purpose of acquiring, selecting, storing, retrieving, evaluating, analyzing, and synthesizing a body of information or data in a clearly defined specialized field. Here the emphasis is on analyzing, evaluating, synthesizing, and repackaging of information for the purpose of enabling users to better assimilate the information. The Directory contains information on the:

(a) name of the Center,

(b) its address and telephone number,

(c) names of the Director and staff,

(d) sponsor,

(e) year started,

(f) mission and scope description,

(g) services, and

(h) types of qualified users.

Examples of the type of nation-wide information analysis centers covered by this Directory are:

(a) Thermophysical Properties Research Center

(b) Mechanical Properties Data Center

(c) Non-destructive Testing Information Analysis Center

(d) National Oceanographic Data Center.

To repeat, these Directories:

(i) A Directory of Information Resources in the United States;

(ii) Directory of Federally Supported Information Analysis Centers

are excellent reference tools and in terms of a first approach to USA Federal information resources they are a "must."

Each federal agency is responsible for acquiring and providing information required for (a) carrying out its mission and responsibilities and (b) documenting the results of its work. By examining the name of the agency, the kinds of information which can be obtained from the agency usually become apparent. For example, the Department of Commerce would be the most likely place to go to obtain technical information required for industrial activities, such as data on fireproof materials, building materials, thermodynamic properties and microwave spectral data. The National Aeronautics and Space Administration is responsible for information on aeronautics and astronautics; the Atomic Energy Commission is responsible for information on nuclear energy and the submolecular structure of matter; and the Office of Education would have knowledge of information concerning the field of education.

Since we are talking about sources of information at this point, it is well to remember that the agency itself may not provide a direct answer to the request, but may refer the inquirer to the sales outlet where the specific documents or data may be obtained; I will discuss these outlets a little later.

4. Media for Processing, Announcement, and Dissemination of Information

The federal agencies provide information in just about every media that can be imagined. These include a full spectrum in the form of reports, books, microforms (such as microfiche), aperture cards and film cartridges, motion pictures, still pictures, charts and maps. Many agencies also provide exhibits of work being performed by their subdivisions for use at conventions, meetings, trade fairs, and many other types of public gatherings.

Informational media for the processing, announcement, and dissemination of information which are available from the federal agencies include abstract journals and publication lists. Let us describe some examples of several types of these media:

A. Abstract Journals

U.S. Government Research and Development Reports, USGRDR, includes federal publications and data files currently released by U.S. Government departments and agencies for public sale through the National Technical Information Service (NTIS). These publications and files, U.S. Government-sponsored translations, and some foreign reports are all announced in USGRDR. They are cited by 22 subject fields, each divided into subject groups. The prices at which NTIS sells paper copy, microfiche, magnetic tape, punched cards, microfilm, or facsimile, together with ordering procedures, are described in the introduction to each issue. The semi-monthly issues of USGRDR are sold by NTIS (Springfield, Virginia 22151) at the annual subscription price of $30.00 ($37.50 foreign); single copies $3.00. The corresponding, but separately issued, semi-monthly index issues (USGRDR-I), which comprise corporate author, subject, personal author, contract number and accession/report number indexes,are sold on subscription by NTIS at $22.00 a year ($27.50 foreign), with quarterly and annual cumulations issued in several separately-priced volumes.

Nuclear Science Abstracts, NSA is a semi-monthly abstract journal covering the international nuclear science literature. Approximately 53,000 items were abstracted in NSA during 1970. Subject, personal author, corporate source, and report number indexes are included with each issue. Annual and quarterly cumulative indexes are also published. NSA is available from the Superintendent of Documents, GPO, as SD No. Y3.AT7:16. The annual subscription rate for the semi-monthly issues is $42.00 ($52.50 foreign); single copies are priced at $1.75 ($2.19 foreign); and the annual subscription rate for the annual cumulative indexes is $38.00 ($47.50 foreign). NSA is also available on an exchange basis with universities, research institutes, industrial firms, and publishers of scientific information, both domestic and foreign.

Scientific and Technical Aerospace Reports, STAR (NASA), is a comprehensive abstracting and indexing journal covering current worldwide report literature on the science and technology of space and aeronautics. Publications abstracted in STAR include scientific and technical reports issued by NASA and its contractors, other U.S. Government agencies, and by corporations, universities, and research organizations throughout the world. Pertinent theses, NASA-owned patents and patent applications, translations and other separate documents are also abstracted. The citations and abstracts in STAR are grouped in 34 subject categories for ease of scanning. Six indexes are included in each issue: subject, personal author, corporate source, contract number, report/accession number, and accession/report number. Cumulative index volumes are published semi-annually and annually. STAR, which is issued on the 8th and 23rd of each month, is available to the public postpaid on subscription and in single copy, as are the semi-annual and annual cumulative index volumes, from the Superintendent of Documents, GPO, as SD No. NAS1.9/4. The annual subscription rate for the semi-monthly issues is $54.00 ($68.25 foreign); single copies are priced at $2.25 (25% extra for foreign mailing); and the annual subscription rate for the cumulative index issues is $30.00 ($35.00 foreign). The price for single copies of the cumulative index issues will vary according to the number of pages. STAR is also available on an exchange basis with universities, research institutes, industrial firms, and publishers of scientific information, both domestic and foreign.

Selected Water Resources Abstracts is a semi-monthly journal which includes abstracts of current and earlier pertinent monographs, journal

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articles, reports and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifiers. Selected Water Resources Abstracts is published for the Water Resources Information Center by NTIS. The annual subscription is $22.00 ($27.00 foreign); the single copy price is $3.00.

Computer Program Abstracts, CPA (NASA) announces documented computer programs that have been developed by or for NASA, the Department of Defense, or the Atomic Energy Commission and have been released for public sale through COSMIC (Computer Software Management and Information Center). The announced programs are not limited to aerospace and nuclear engineering but cover many topics in aeronautics, biosciences, chemistry, electronics, geosciences, instrumentation, physics, structural mechanics, and thermodynamics. CPA is fully indexed by subject, originating source, and equipment requirements, and announces separately the prices for (i) the programs (on 7-track tape at 556 bits per inch, card in image-card format unless specified otherwise by the purchaser) and (ii) the documentation. CPA is issued quarterly and is available on subscription from the Superintendent of Documents, GPO, as SD No. NAS1.44, for $1.00 annually (25¢ additional for foreign mailing); 25¢ per single copy.

B. Publication Lists

In addition to abstract journals some government agencies issue publication lists which I feel may be of interest to you. Let us look at four quite different examples.

1. Monthly Catalog of Government Publications. This document is a listing of government publications which are both printed and processed by the Government Printing Office. The catalog gives a preview of documents to be issued as well as those currently on sale. In addition, it gives information on how to order publications, corrections for previous monthly catalogs and a list of government authors. The document is issued by the Superintendent of Documents, GPO, as SD No. GP3.8; the per-copy price is 75¢ and the annual subscription price is $7.00 ($8.75 foreign).

2. Index of Federal Specifications and Standards (General Services Administration). This index is an annual consolidated listing of specifications, standards and handbooks used for the purchase of items by the Federal Government. The Index contains an alphabetical listing by item, a group listing arranged alphabetically (by title), and a numerical index by specification number. The Index also gives the price for each individual specification or standard. Except for military specifications, those that are listed are available from the General Services Administration, Business Service Center, 7th and D Streets, S.W., Washington, D. C. 20407. Individual unclassified Military Specifications are available from the Commanding Officer, U.S. Naval Publications and Forms Center, (NPFC 103), 5801 Tabor Avenue, Philadelphia, Pa. 19120. The Index of Federal Specifications and Standards, issued monthly, is available from the Superintendent of Documents, GPO, as SD No. GS2.8/2:971 at $9.00 ($11.25 foreign).

3. Index of U.S. Voluntary Engineering Standards (NBS). Computer-produced and arranged by Key-Words-In-Context, this index lists more than 19,000 voluntary engineering and related standards, specifications, test methods, and recommended practices published by some 360 technical societies, professional organizations and trade associations in the U.S.A. It is sold by the Superintendent of Documents, GPO, as SD No. C13.10:329, at $9.00 ($11.25 foreign).

4. Annotated Accession List of Data Compilations. This publication

lists the documents acquired by NBS Office of Standard Reference Data on significant world-wide reference data compilations and their abstracts. The documents are grouped into the following categories: general collections, nuclear properties (including fundamental particles properties), atomic and molecular properties, solid state properties, chemical kinetics, colloid and surface properties, mechanical properties, and thermodynamic and transport properties. Sources of availability for the listed publications are also provided. This annotated list is for sale by the Superintendent of Documents, GPO, as SD No. 2044.

C. Thesauri

Your Chairman suggested that I might mention briefly a basic tool used by information organizations which may be of interest to those of you setting up your own information programs. To assure uniform indexing practice and maintain bibliographic control of information flowing into any system for processing, announcement, storage, and retrieval, a subject authority list called a Thesaurus is required. U.S. Government agencies which have developed formally structured Thesauri for this purpose include:

1. The Department of Agriculture has produced the Agricultural/ Biological Vocabulary, a listing of thesaurus-structured subject headings to be used by the Department of Agriculture to index and catalog both published materials and research in progress. It contains approximately 12,000 terms; volume I at $2.50 is the categorized list, volume II at $3.50 is the alphabetical list, and a supplement of 1967 is sold by the Superintendent of Documents at $1.50.

2. The National Aeronautics and Space Administration has produced the NASA Thesaurus; NASA SP-7030. It is a structured listing of terms authorized for indexing aerospace scientific and technical information in NASA. It contains approximately 16,000 terms, with an alphabetical listing of subject terms, a hierarchical display, a category term listing, a permuted index, and postable terms. It is available from the Superintendent of Documents, GPO, as SD No. NAS1.21:7030 at $8.50 ($10.65 foreign).

3. The Library of Congress has developed the Subject Headings Used in the Dictionary Catalogs of the Library (Seventh Edition, 1966). A listing of subject headings established for use on the catalog cards prepared and sold by the Library of Congress. A conventional cross referencing scheme (See, sa, x, xx) is used. The list is available at $15.00 from the Card Division, Library of Congress, Building 159, Navy Yard Annex, Washington, D. C. 20541.

4. The Department of Defense has prepared the Thesaurus of Engineering and Scientific Terms. The thesaurus was developed jointly by Project LEX (Office of Naval Research) and the Engineers Joint Council, for use by the Department of Defense as a basic reference in information storage and retrieval in the fields of engineering and science. It contains approximately 23,000 terms, permuted index, subject category index, and a hierarchical index. It is available at $19.50 from the Engineers Joint Council, 345 E. 47th Street, New York, New York 10017.

5. Points of Availability--Sales Outlets

The four main sales outlets for federal agency information are:

(a) the National Technical Information Service,

(b) the National Audiovisual Center,

(c) the Science Information Exchange, and

(d) the Office of the Superintendent of Documents, GPO.

Let us take a closer look at each one in turn.

(a) National Technical Information Service (NTIS), Department of Commerce, the successor to the Clearinghouse for Federal Scientific and Technical Information, was established in 1970 to coordinate the Department of Commerce's business and technical information activities and to serve as the primary focal point within the Federal Government for the collection, announcement, and dissemination of technical reports and economic data. Documents are announced in its USGRDR, the abstract journal, and indexed in the USGRDR-I, mentioned earlier. In its current awareness program NTIS provides a "Fast Announcement Service" (FAS), organized into 57 subject categories. Selected Government research and development reports are highlighted as soon as they are received by NTIS. The holdings of NTIS may be purchased either in hard copy form at $3, $6, or $9 depending on size, or as microfiche at 95¢ per fiche. Fast processing is assured by a coupon ordering system. Subscription rates for the current awareness and announcement services are based on a sliding scale which is dependent upon the number of categories desired by the customer.

Other products include indexed information on production practices, microfilms on patent specifications, a "Listing of Federal Stock Numbers" that relate to manufacturer's parts numbers of the Federal Supply Catalog, AEC-NASA Tech Briefs, Joint Publications Research Service (JPRS) translations, and the "Reports of NRL Programs", a monthly publication produced by the U.S. Naval Research Laboratory summarizing its research work.

(b) The National Audiovisual Center (NAVC) of the National Archives and Records Service, General Services Administration, Washington D. C. 20409 was authorized in 1968, and began operation in July 1969. Its objective is to achieve the most efficient use of Federal audiovisual materials and to furnish information on Government sources of audiovisual materials. It sells copies of motion pictures, filmstrips, slide sets, audio tapes, video tapes, and special audiovisual kits and packages which are produced by various Federal agencies and provided to NAVC. A loan service is provided to Federal agencies. The Center provides several directories describing its products and services, including a catalog of the motion pictures and filmstrips which are for sale by the Center. Three catalogs are available at no charge: U.S. Government Films, a Directory of U.S. Government Audiovisual Personnel, and a List of U.S. Government Medical and Dental 8mm Films. Prices for the films are nominal and range from about $85.00 for a 44-minute reel of film to 15¢ per foot for replacement color footage with a minimum of 100 feet of film. The films cover fields ranging from agriculture and medicine through science and technology to manufacturing and shop techniques.

(c) The Science Information Exchange (SIE), Smithsonian Institution at 1730 M St., N.W., Washington, D. C. 20036 was established in 1949 under sponsorship of a group of Federal agencies. Since 1953 it has operated under the aegis of the Smithsonian Institution, with partial support provided by the National Science Foundation as a service to the national research community. The SIE receives, organizes, and disseminates information about current and completed research work in the life, physical, and social sciences. Over 1000 research organizations, including the Federal agencies, private foundations, universities, state and city governments, industry and foreign sources cooperate and/or participate, and over 100,000 records of research projects planned or in progress are registered annually.

The mission of SIE is to assist the planning and management of research activities supported by Government and non-Government agencies and institutions, by promoting the exchange of information that concerns subject matter, level of effort, and other data pertaining to current research in the pre-publication stage. Its purpose is to assist directors and administrators to avoid unwarranted duplication. In addition it informs individual investigators about others currently working on problems in their special fields. It has records of who is doing what and where, but it does not have data on the results of the research.

There are eight products provided by the SIE. First of all, six types of computerized searches (including subject, administrative content, investigator searches by name, accession number retrieval, and historical and standard computer tabulations of projects). In addition, by special negotiation it will prepare subject-field catalogs and special compilations. The fees for the searches are based on the computer time for the search of the records and not on the number of records retrieved.

(d) Superintendent of Documents, Government Printing Office, Washington, D. C. 20402, was created by Congressional Joint Resolution 25 on June 23, 1860. In addition to providing for printing of Government documents it also makes provision for the sale of those documents which it prints. The Superintendent of Documents is a subdivision of the Government Printing Office (GPO), which provides the sales outlet. It will supply the pamphlet Price List of Government Publications, upon request. In addition, individual announcements are made of unusual publications that may be of special interest. To be placed on mailing rosters to receive these announcements, one needs only request it by writing to the Superintendent of Documents. Sale prices are based on the cost of operating the publication service. A discount of 25 percent is allowed to book dealers and quantity purchasers of 100 or more copies of a single title.

6. Conclusion

Let us now look briefly at what we have covered:

(i) First of all, we attempted to show the interest of both the Congress and the Office of the President in making available the information resulting from Government efforts.

(ii) Secondly, we mentioned how one can obtain information on information resources.

(iii) Thirdly, we covered the media for the processing, announcement, and dissemination of information. Here we discussed Government abstract journals and publication lists. We touched only briefly on thesauri.

(iv) Lastly we discussed the sales outlets: the National Technical Information Service, the National Audiovisual Center, the Science Information Exchange and the Superintendent of Documents.

Now, there are still two special classes of information I have been asked to mention:

Evaluated Physical Constants-Standard Reference Data.

The dissemination of evaluated and standard data is a main responsibility of NBS in coordinating a complex of data centers known as the National Standard Reference Data System (NSRDS). The objective of NSRDS is to provide to the U.S.A. scientific and technical community optimum access to the quantitative data of physical science, critically evaluated and compiled for convenience. The NSRDS was established in 1963. In 1968 Congress endorsed and strengthened the program by passing the National Standard Reference Data Act. A monthly Journal of Physical and Chemical Reference

Data will contain material prepared under the NSRDS program; it is to be published by the American Institute of Physics and the American Chemical Society. This continues the Annotated Accession List of Data Compilations described under B4.

Domestic and Foreign Economic Data.

Almost every agency of the U.S.A. Federal Government is involved in some manner or other with domestic and foreign economic data. To provide you with a feel for the wide variety of available data, we note several of their publications.

(i) The U.S. Department of Commerce, Office of Business Economics, publishes the Survey of Current Business, a monthly journal with text and charts on business trends, gross national product, personal and farm income, balance of international payments. It is available from the Superintendent of Documents, GPO, as SD 73 at $9.00 ($12.00 foreign), which includes a weekly supplement, Business Statistics.

(ii) The U.S. Federal Power Commission, Bureau of Power, publishes Electric Power Statistics, a monthly journal devoted to all aspects of the production and consumption of electrical energy generated by both private and public electric utilities. Subscription price is $3.00 a year, available from the Superintendent of Documents, GPO, as SD 99.

(iii) The U.S. Federal Trade Commission, Bureau of Economics (Division of Financial Statistics), publishes the Quarterly Financial Report for Manufacturing Corporations under a joint program with the Securities and Exchange Commission. It provides a balance sheet for U.S. industry made up of uniform statistics from a sample of corporate manufacturers. Subscription price is $2.00 a year, available from the Superintendent of Documents, GPO, as SD 132.

(iv) The National Science Foundation, Office of Economic Studies, issues Federal Funds for Research, Development and Other Scientific Activities on an annual basis, as a result of surveying the federal departments and agencies to determine the funds they provided or intend to provide in support of scientific activities in the preceding, current, and next fiscal years. The data covers the character of the work undertaken--basic research, applied research, or development; the program and fields of science that received support; and the types of organizations that performed the work. The report (available from the Superintendent of Documents, GPO, at $2.50, as SD 2605) shows the trend of overall funding of federal research; the distribution by states of federal research and development funds; and compares the pattern with earlier years.

International Information Exchange Agreements

As might be expected almost every Federal agency has information exchange agreements with counterpart agencies abroad. These would include the Department of Commerce; the National Bureau of Standards; the Library of Congress; the Department of Agriculture; the Atomic Energy Commission; the National Aeronautics and Space Administration; the Department of Health, Education, and Welfare; and the Department of Labor. There are a great many such agreements and it would be impossible to discuss them in any detail in the time at my disposal. All of them are based on the exchange of specific media and types of information.

I hope that I have given you sufficient useful leads to the wealth of data and information that is available to you. Although I did mention prices for many of the products and services, most are available on an exchange basis. We encourage and solicit exchanges. It is the U.S. Government's policy to share its information and its compilations of data. The resulting dialogs and relationships benefit all.

Paper 4.2 - Government Responsibility for Information for Industry

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Before attempting to define the responsibility of government to provide information for industry, it seems appropriate to establish the framework in which industry operates in developing economies, its basic needs for information and the way these needs are now met. In developing economies, particularly in Latin America, industry operates under strong import protection, and true competition between firms is lacking. Under these circumstances, inefficient industries are able to prosper despite a very low level of technological and managerial development. The existence of monopolies, the lack of a true industrial mentality, and the limitations imposed by the small size of the market are also important elements in the existing social and economic structures. Within these structures industry is developing but the rate is slow and far from that required for economic and social goals. Nevertheless, new factories are being installed and existing plants are being expanded through the introduction of new products and processes, which are largely imported directly from the industrialized countries.

The available information for industrial expansion and especially for the selection of technologies is, in almost all cases, fragmentary. It is obtained mainly through foreign parent organizations, agreements with foreign firms, visits of management to industrialized countries, local representatives of equipment producers and sometimes through technical literature and reports from technical institutions. These channels of information used by industry have important limitations. First, they do not offer alternative choices. Obtaining information for a given process from several sources is an almost impossible task. Moreover, managerial decisions also require technical and economic evaluation of the various technologies available.

Second, because these channels are open only to a few firms, they do not satisfy the need for a dynamic transfer of technology at the national level. Consequently a large number of inefficient firms may co-exist along with a well equipped factory.

Third, these channels do not promote either the use or the development of local technical capabilities generally, because they constitute a direct link between firms. Due to the lack of adequate mechanisms, management does not make use of scientific capabilities, and conversely scientists, who are usually working in the universities, do not become involved in the problems of industry. Technological research and standards organizations are in general not developed enough to fill the gap. Therefore, technological dependence is considerable. Fourth, the channels are not open enough to meet the needs of the financial institutions and government agencies that play an active role in the industrial development process by approving, rejecting or orienting managerial decisions.

Quite frequently enterpreneurs decide to employ capital-intensive technologies because in the short run they offer the best economic choice, while national social goals are best met by the use of labor-intensive alternatives. Let us explore the reasons for this conflict. Management acts in the best interest of its enterprise; decisions are molded by existing structures. Financing for capital expenditures is relatively easy to obtain through development banks, but loans to pay labor costs are almost impossible to obtain. Moreover no penalty is paid for idle productive capacity in economies where price is determined by adding a "reasonable" profit percentage to actual cost, which includes depreciation for all capital investment.

What is needed is a National Information System that can perform the following functions:

(a) adoption of a national information policy within the framework of industrial development, technological transfer, and scientific and technological development policies;

(b) liaison with international information systems to obtain a constant and adequate flow of information from abroad;

(c) coordination of national technical capabilities to help them in solving industrial problems through a well-oriented research and development effort, which should include technical evaluation of available technologies; and

(d) extension services and technical assistance to disseminate information to industry, and allow for wider use of the technical information sources that are available in our libraries.

The main aspect we want to emphasize is that in less developed countries the information system must include the selection and evaluation of technical information, especially in relation to equipment and processes. The general approach suggested is quite similar to the one followed by the standard institutes in performing their specific function. Once the need for a new standard is recognized, the initial effort is to obtain information about existing standards at the international and national levels. These standards are evaluated in terms of the technological capability of local industry to meet them and in terms of the needs of consumers. A draft standard is discussed with representatives from industry, government, and the technical institutions. It is then published to give all affected parties the opportunity to make comments and observations. After final approval, a second dissemination effort is made.

The government's responsibility for providing information to industry in a less developed country is basically to organize such a National Information System. Organizing this system does not mean performing all the functions required of the system. Proper and efficient coordination of governmental, scientific, and technological institutions is a prerequisite for a successful information network. The formulation of national information policy is clearly the responsibility of the central government. It may not be expressed explicitly as a separate function, it can be defined as part of other policies such as the industrial development policy, the scientific and technological development policy, etc. In any case, it should be coherent.

Some of the Latin American countries have been making interesting progress through the creation of national scientific and technological councils or similar bodies, which have stimulated a more organized effort on the part of the national scientific and technological institutions and a different attitude on the part of the government towards science and technology. These councils are becoming interested in the field of information as a tool for technological advancement, and some of them are taking initial steps in the organization of national systems.

Since developing economies require that a major effort be made to put an information system into operation, it seems advisable for them to have a central coordinating agency to act mainly as a clearinghouse. According to the findings of a recent OAS evaluation mission that visited eight Latin

American countries, there are three types of institutions which under present plans are assuming or will assume the role of a central coordinating body: a) national technological research institutes, b) national councils for science and technology, and c) national technical assistance organizations. In all three cases the institution employed is an agency of the government.

Technological research institutes offer the advantage of having a close relationship between sources of information and the disseminating agency. If the research institute provides industry with technical assistance such as on quality control, the liaison with small and medium size enterprises will be facilitated. The national councils for science and technology are closer to the scientific community than to industry. This will not be a major difficulty if effective collaboration with the centers for technical assistance to industry is created. Since the councils are solidly established in the governmental machinery they have a convenient relationship with the economic decision-making organizations. The technical assistance organization, because of its strong contact with industry, offers the advantage of orienting requests for information to the actual needs of the users, but it is separated from the sources of scientific information, and its leadership may not be accepted by the institutions that should make up the system.

The National Information System should be made up in such a way that special consideration is given to the best utilization of existing institutions. Each of the three alternatives has its advantages, and the final selection should be based, in each country, on the best capability to fulfill the task. The creation of new institutions should be avoided unless they are clearly necessary. At the same time the system should be open to all technical institutions, professional societies, government agencies, and managerial and trade associations. All these should be encouraged by every means to become part of the network. Where feasible, the establishment of subsystems should be encouraged on the basis of the specialized capabilities possessed by trade associations or research organizations in specific industrial branches, such as tin, steel, ceramics, wood products, etc.

The first step in the operation should be a major promotional campaign. Potential users should be made aware of the type and extent of the information services available. Intensive use of industrial extension services, productivity centers, and standards organizations would be extremely useful to reach both industrial management and labor unions. These institutions are in close contact with industry, and they offer the possibility of obtaining feedback to the central agency. The effectiveness of the system can thus be measured in terms of meeting the real needs of the users. Adjustments and improvements can be made in the service.

I have been stressing two aspects: the utilization of technical capabilities and the efficient use of existing institutions. It has to be recognized that in developing economies a major effort must be made to foster the development of scientific and technological institutions. Recently Latin American governments have started to adopt a more active role in that direction, but stronger support still is needed if science and technology is to play a major role in economic development. It has been said, and it is worth repeating, that unless real scientific capability is developed, there will be no real possibility of mastering either the design or the selection of the technologies that are best adapted to economic and social goals. This is also true with respect to services to industry, including information services.

In highly developed countries there is a clear understanding of the benefits derived from properly organized and operated information services. There are several organizational approaches used in the various national systems. The Russian system operates on the basis of a centralized information network. This includes processing, abstracting, bibliographic services for national and foreign literature, and a unified reference and information system based on a nationwide network of coordinated reference collections. The Canadian Technical Information Service is a branch of the National Research Council of Canada, a government agency which offers to industry technical and industrial engineering services through field officers who visit individual companies. It also offers a technological development service which is designed to provide information to individual firms on new research and technological developments of potential value to them. This service involves the selection of suitable material by experienced engineers.

In the United States, the information system is highly decentralized. In the private sector, there are a large number of professional societies, universities, independent nonprofit and for-profit organizations. The federal government plays a significant role through national libraries, referral services, document depots and national networks. Among these federal information resources, our host, the National Bureau of Standards, merits special attention. A brief analysis of the annual report of NBS for fiscal year 1969 shows that the basic responsibility of NBS since its establishment in 1901 has been to act as the U. S. central measurement laboratory. This responsibility has been expanded as a result of the continuous changes in the technological level of industry. A clear indication of such expansion is that the NBS has been a leader in developing new technology in the field of computers. The technical expertise achieved by research in sophisticated measurement procedures has been used to solve problems in other agencies of the government. A valuable information service is provided for data in the physical sciences. Information is also provided on materials and on new data useful in solving materials problems. Another important aspect of the work of NBS is the development of standards of measurement and the provision of more than 700 standard reference materials to industry.

In summary, the NBS is a good example of how a government can meet its responsibilities to provide a sound basis for furnishing assistance and information to industry.

NBS SPECIAL PUBLICATION 359 - Metrology and Standardization in Less-Developed Countries: The Role of a National Capability for Industrializing Economies.
Proceedings of a Seminar, 1971.

Paper 4.3 - Publications; Documentation Indexes

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Our session, "The Dissemination of Information", naturally focuses on the specific bits of information that are being transferred, but I think it is important to remember that we are basically talking about the transfer of some immaterial substance represented by those symbols and put on those records. The handling of the records themselves is not the main point of the exercise. After Dr. Condon's comments on the UNIDO session he just attended, I want to express explicitly my caution against any nation adopting as a preferred model for information dissemination a system which is primarily under the control of professional information specialists. Don't do it! Their preferred modus operandi is apt to be a shotgun rather than a rifle; a broadcasting of information everywhere hoping that some of it will find use; a system which pushes information onto people rather than one which responds quickly and precisely to the needs of an individual or a small group. We have a mixture of both types of systems in the U. S.--both the rifle-shot system and the shotgun system--and it seems to me that those systems which operate more directly in response to individual needs do a better job with fewer resources. Since resources management is always a problem in developing countries, I would strongly recommend that they focus on the more individually tailored information systems.

Two weeks ago, I had the pleasure of meeting Señor Fontes and also the privilege of addressing a group from Latin America under AID-OAS sponsorship where the entire seminar was on information. Today I will focus on the use of information in areas of substantive concern to this group, and discuss some of the barriers to effective use of information in technology transfer. Mr. Day did a magnificent job of outlining in a very broad way the various types of publications, indexes, and other records that are available from within the U. S. Federal Government to help.

It is well for us to remember that although information is necessary for technology transfer it is not sufficient. Other steps have to be taken, some of which Señor Fontes mentioned in his paper. Other speakers today will discuss some of the other factors that are necessary for technology transfer. Let me define my use of the words "technology" and "technological information." I use them broadly enough to cover the fields of economics, education, or any of the more traditional hard sciences in engineering fields, the social sciences, the art of managing, any of the areas where the problem is to know how to do something. That is technology; applying knowledge to useful social purposes of any kind.

In fact, I am sure the United States could learn from some of the countries represented here about the technology of managing inflation. Some of them have had considerably more experience than we have had in living with large doses of inflation, and I am sure that the technology that they have painfully acquired would be helpful here. However, each nation has to develop its own information transfer capabilities in accordance with its national tradition. The system adopted by one country with one set of traditions is not necessarily transferable to another country.

Now, let me mention very briefly some barriers to technological information transfer. Most policy makers, most executives, most managers assume that communication happens by itself without any explicit attention from them. They assume that some (preferably) nonprofit organization, or some of their own professional staff working as volunteers in a nonprofit organization, will somehow arrange the literature in such a fashion that it can then be used for management purposes. It happens that communication is a very labor-intensive process; it requires a great deal of attention; and it requires considerable resources. It does not happen by itself. Top management must give specific recognition that they are aware that the problem of the management and effective transfer of technological information is worthy of their serious concern. I have spent some time considering the relation between the total communication infrastructure within a nation and the state of its industrial development. It is no accident, I believe, that the two nations which have the most telephones per capita, the United States and Sweden, happen to be leaders in high technology fields. The telephone is a very valuable instrument for minimizing barriers to the transfer of technical information.

Another barrier to effective information transfer is the simple "explosion" of the literature in all fields. You are well aware of how fast publications are expanding, both in the size of any individual volume, as well as in the number of volumes. A new factor, too, in recent years has been a more task-oriented use of the literature. Instead of simple chemistry, it is now environmental protection, which has some chemistry involved in it. The literature is used for more specific interdisciplinary purposes.

Another barrier is, of course, language. My compliments to all the people here whose native tongue is not English. I am very impressed with the fact that the entire Seminar has proceeded effectively while using one standard language, which happens to be English in this case. It is not always true, and we have a long way to go before we are able to use language effectively in our technical information transfer. This is especially so when we consider the problem of transferring information at the technician level, the lay level, and the non-scientist level. Any nation considering its information system must make provision for some unit which effectively translates from an international language to the native tongue, or from the language of a scientist to the language of the practitioner. Señor Fontes mentioned that technical assistance organizations have provided some of that capability.

Another barrier to effective information transfer is the normal human resistance to change. There has to be an open-mindedness on the part of individuals in order for them to receive information. We are fortunate in this country in that a substantial part of the population is accustomed to the idea of change and is not disturbed by it. I am sure that in many developing countries this is a very important barrier to effective information transfer.

Another barrier is the proprietary interest involved in some information. The U. S. Government turns out a great deal of printed information, and all of it is made available freely to the public. No one can appropriate the information to his private purposes. This is a great resource in this country. As we develop new forms of information records; as we market computer tapes; and as we market microfilm; and as we market on-line access by telecommunication lines to some central library, we are adding to this resource. However, we must develop the proper balance between proprietary interests on the one hand, which are necessary to promote private initiative in information transfer, and on the other hand the long-term investment by the public in what I would call adult education.

Another barrier to information transfer is the variation in documentation procedures. This is a field of standardization which may not be your specialty, but it is a most important field. Like all other standardization efforts it is slow and painful, and progress seems to be measured in decades. Federal agencies have worked under the leadership of COSATI, which Mr. Day mentioned earlier, to develop certain standards for representation of bibliographic information. They will make it easier for computers to interchange information. COSATI continues the work of developing standards. In addition, of course, outside groups--computer manufacturers, microfilm manufacturers, professional societies, library groups, and others--are continuing their efforts in cooperation with the Government to develop standard documentation procedures.

A final barrier to effective information transfer is the lack of standard mechanisms and devices to handle the new information products. Books are universal tools; everybody can handle a book. All it takes is a pair of hands and a pair of eyes. But not everyone can use some of the new information technologies like microfiche, punched cards, or computer magnetic tapes. It takes a certain standardized set of devices and tools to use them.

Now let me turn to some additional information about the sources of technological information within the U. S. Government. As Mr. Day pointed out, the Department of Commerce has established within the last few months the National Technical Information Service (NTIS) of which I am the director. This service is based on an organization which has existed since 1950 called the Clearinghouse for Federal Scientific and Technical Information. The earlier organization was instituted because of the Federal Government's concern at the end of World War II that the technical advances made here and abroad were shrouded in secrecy. It was concluded that some program of making that information available to our citizens was necessary. Over the course of the last twenty years, the Clearinghouse has assumed more and more the central role of making publically available the reports produced by federal agencies. It has, until recently, concentrated in the fields of science and technology. Part of the reason for establishing NTIS was to broaden the subject coverage. It is our clear intent to make available through NTIS reports of all kinds--reports of interest especially to commercial businesses and to manufacturing industries, both small and large. They will cover the fields of economics and managerial science, operations research, land management, transportation technology, and transportation management.

NTIS is a very large operation already, and it will no doubt be even larger when we take on these additional assignments. It has about 400 people who send all over the world about three-quarters of a million reports each year. It handles about 50,000 new reports each year, and it supplies those reports either in hard (printed) copy or in microfiche form. It supplies about three million microfiche copies each year, again all over the world. About 20 percent of our output goes abroad. The service offered is of two general types: (1) we can supply material on subscription, or (2) we can answer requests as they come in. We are trying to make it simpler for people to send in requests by instituting a business type order-and-billing system instead of insisting on payment in advance. We have already begun to market computer tapes containing statistics on economic, demographic, marketing, and production subjects. These tapes are used by many of our more sophisticated manufacturing and marketing firms, and will be available later this year to handle specific requests from individuals around the country. We envision a network of field offices through which this information will be available, much of it over tele-communication capabilities.

I want to mention two important libraries which Mr. Day did not cover, the National Agricultural Library and the National Library of Medicine. These are very important resources and are responsible for the production of two very important indexes, the Bibliography of Agriculture and the

Index Medicus. Both are available on subscription, and both libraries are willing to answer specific requests.

Let me summarize by saying that over the last 15 years, as a result of a great deal of national soul-searching, vigorous federal effort, federal support and encouragement of the private sector, and as a result of some private entrepreneurs' efforts, we have now developed within this country a rather complicated network of nonprofit government-operated, privately-operated, and for-profit-operated information services. The welding of these services into an effective system in which there is relatively little duplication of effort will take a great many years. It may never come to pass, but we will continue to work towards such a system. In the meantime, NTIS will be glad to provide whatever help we can to any of the less developed nations with regard to the organizational structure of an information system, or on a specific request for technological information know-how.

SESSION 4 - THE DISSEMINATION OF INFORMATION

Paper 4.4 - Extension/Productivity Services Via A Developing Country Standards Institute

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and

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I. Characteristics of Viet Nam Industry

The manufacturing industry in Vietnam has a rather short history. While some industrial activity existed prior to 1954 when the country regained its independence, the main producing facilities were used in the processing of agricultural products for export, such as rubber and rice. Few enterprises existed as public or private corporate entities. Other small industrial units, individually owned and operated, established with limited capital and utilizing mainly family labor, were more family undertakings than industrial enterprises.

From Family Undertakings to Small Industrial Enterprises:

After the French departure, people with small family undertakings left with new opportunities for their technical and commercial skills, and with some money to spare, began to add new machines and a few non-family employees to their operations. This type of evolution was predominant in the first years of industrial development. What these family enterprises lacked in advanced manufacturing techniques and modern equipment, they more than made up with low labor cost, quick delivery, and products that satisfied the needs of individual consumers. They were willing to turn their long laboring hours into small profits.

More profitable industrial projects required capital investment beyond the financial capabilities of small family ownership. To encourage investment, incentives such as tax holidays, remission of import duties, financial support, easy acquisition of land and provision of utilities in industrial parks, and other privileges were planned and implemented by the government, and reserved for the larger and growing corporate and partnership enterprises. As the last and most damaging blow to the small family undertakings, the privilege of direct import of equipment and raw materials which up to 1970 was accorded to all enterprises, was now reserved for corporate and partnership enterprises. In place of the small family undertakings, there now appear company enterprises, many owned by members of the big rich families. The operations of these new enterprises have improved greatly since the days of the small family undertakings. However, some of the characteristics of the latter still persist, in that they substitute labor for capital to the greatest extent possible, that they have working conditions which are far from optimum, and that they lack of modern quality and process controls. There are no accurate figures of the number of existing small enterprises in the industrial picture of Vietnam; but an intelligent guess would indicate something like 90 to 95% of the industrial plants employing 100 or fewer workers.

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Lack of Quality Consciousness:

In these still early stages of industrialization while manufacturing technology is underdeveloped, Vietnam faces many technical problems. To develop and support its industry, Vietnam imports machines, materials, manufacturing processes, and often manpower from many countries. The United States, Canada, Great Britain, France, Germany, Italy, Japan, Taiwan, India, and Australia are some of the important suppliers. Machines and materials are purchased from the suppliers with the lowest bids. Specifications of the product are mentioned in the contract, but checking for conformation is not always required. Whether the materials meet the specifications or not, the small manufacturers use them without rechecking, relying mainly on the supplier's guarantees.

Although an appreciable number of manufacturers have the ability to operate modern plants with process control, many do not feel the need for specifications and quality control of their products, in an economy where the demand by consumers far exceeds the supply of goods. Competition rarely exists to the benefit of the consumers. This is not the consequence of a monopoly system or of a protectionist policy, but merely that of early development. The manufacturers prefer to invest their money in the more profitable industries, or share advantageously a high demand market, than to compete with others for markets where the demand is discriminating and thus makes profits less attractive and the work harder. As a result of the lack of controls, intermediate materials and final products, more often than not, are variable in quality and price.

The Lack of Calibration and Testing Laboratories:

To the individual consumers and even to the organizations buying in large quantity, the testing of products may be impossible because the country has no commercial testing laboratories. Some laboratories operated by various government agencies and educational institutions have pieces of equipment which can be used for testing purposes. However, without calibration facilities, this equipment has never been checked or recalibrated since the day of purchase, so that the measurements can hardly be called meaningful. An attempt to use these scattered facilities to provide testing services has brought only limited success, because the organizational structure of these laboratories and their specialized purposes allowed little room for deviation from their regular work.

To the small manufacturer desiring to improve his process or product, testing the product may prove to be an expensive undertaking which cannot be performed regularly and often. The laboratory, going out of its way to provide the service, charges rather high fees. Sometimes no instruments are available for the testing, and the product must be sent to a foreign laboratory. Some large enterprises operate their own testing laboratories; but, again, without calibration facilities being available, we have seen testing equipment in plants gathering dust, while the quality of the product deteriorates along with the process machinery and testing instruments.

With centralized control and testing facilities unavailable in the country, the small enterprises have to rely heavily on the suppliers' guarantees for quality and for technical services. There is, of course, a danger in operating an industrial enterprise which relies on such biased sources as suppliers whose main objective is to sell their products. The consequences are often costly, not only because of the high cost of services provided by foreign suppliers or their failure to make good the guarantees, but also because process machinery may be tied up for weeks waiting for a gage or meter to be recalibrated, or faulty equipment may continue to be used while waiting for the result of analyses.

II. Industrial Extension and Productivity Services

From the colonial era Vietnam has inherited no properly staffed institutions through which coordinated industrial development could be implemented. The first agency in charge of industrial extension and productivity services was created as late as 1957 and for the last fourteen years, the Industrial Development Center (IDC) has been the main instrument of the government policy in industrial development.

Industrial Development and Reconstruction Loans:

Most of the small and medium scale industries in Vietnam are handicapped by an acute shortage of capital. In accordance with the government policy to support the industrial investors, IDC makes loans directed towards development of new industries and reconstruction of those damaged by war. The interest rate over the years ranged from 3% per annum and did not exceed 7.5%. The interest on IDC loans has recently been raised to 5-10%, while the rate of interest charged by commercial banks is now 24%. In 1969, IDC loans amounted to 1,667 million piastres (U.S. $15 million).

Technical Services:

To interested investors, IDC can give advice on the areas of profitable investment, and according to the investor's need for assistance, may undertake a part of the project or make a complete study of a project and see to its implementation. The project may involve a market survey for the prospective product; a technical study on raw materials, utilities, manufacturing processes and equipment; the choice of plant site; a financial study to estimate the capital requirements, capital structure, and rate of return. When the investor has decided to go forward with the project, IDC again can help draft the specifications for the required equipment, organize an invitation to bid, and finally proceed to the selection of a supplier. In 1969, IDC prepared 51 industrial projects and drafted 82 books of specifications for process equipment for the pharmaceutical, animal feed, printing, detergent, monosodium glutamate, textile and other industries. To manufacturers, in-plant services are also available. Upon request, IDC can dispatch technicians to the plants to advise on various aspects of production techniques, raw materials surveys, inventory control, or quality control.

Management Training:

Since 1968, IDC has organized for the industrial and business communities a number of business management courses in conjunction with USAID, the "Mission d'Aide Economique et Technique", and the United Nations Development Program. Some courses were designed to disseminate modern management techniques. Some were refresher courses for the top management levels. The increasing participation in these courses as shown in Table 1 has confirmed a growing management and productivity consciousness in Vietnam.

Table 1. Participation in IDC Management Training Program

Year	Number of Participants	Number of Certificates Awarded	Number of Firms Joining	Cumulative Number of Firms
1968	316	176	64	64
1969	471	229	106	170
1970	295	165	41	211

III. The Viet Nam Institute for Standardization

Against this background, the Vietnam Institute for Standardization (VIS) was established in April 1967 by a Prime Minister's Order, and entrusted with the elaboration and implementation of national standards and the testing of materials and products. As a department of the Ministry of Industry (and now of the Ministry of Economy), VIS has been fully supported by the national budget. VIS began its functions in the most difficult conditions with no technical staff, with a meager budget, with a major government sector still unaware of the benefits of standards, and with the industrial sector suspicious of the new organization's good intentions. VIS activities started hopefully in early 1968 with the recruitment of a nucleus staff, to be followed by the government austerity measures allowing no additional recruitment for expansion of facilities to carry on the standardization program. Activities were almost frozen by the military training requirements for VIS technical staff during 1969, while this nation of 17 million people was mobilizing an army of 1 million soldiers.

As 1970 began, with a special grant of 10 million piastres made by IDC and contributions made by other organizations and local manufacturers, VIS broke ground for the first module of a laboratory to provide basic calibration and testing services for industry and to assist in the elaboration of standards. USAID/Saigon through the Industry Division has been working closely with VIS on this project and provides technical assistance needed. The technical staff for the laboratory operation has been trained in the U.S. and USAID provides funds for the purchase of testing equipment and offshore materials. The progress made by VIS has finally convinced the government to allow VIS to double its staff in 1971, and to allocate a 12 million piaster (U.S. $100,000) budget for 1971, more than half of which will be spent to finish the laboratory.

In the meantime, recognizing the limitations of regular government agencies in Vietnam, coping with the problems and needs of industrial standardization, VIS drafted a Standardization Law, based on a different approach to the establishment of a standards organization. The draft, approved by the government in late 1969, was submitted to the National Assemblies for enactment. The Lower House passed the draft standardization law in the closing days of 1970. It is hopeful that the Upper House will consider it in the coming session. The Standardization Law will provide for an expanded organizational structure and adequate budget for a National Institute for Standardization of Vietnam (NIS) and will prescribe related activities for certification marking and preshipment inspection for export products.

Basic Functions of NIS:

The basic functions of NIS can be summarized as follows:

a) to elaborate and publish national standards;

b) to promote standardization in agricultural, commercial, and industrial activities;

c) to inspect, sample, and test materials and products for evaluating their quality and serviceability;

d) to calibrate and service scientific instruments;

e) to specify the standard certification mark to represent the standards and to issue and control licences for the use of the mark;

f) to hold custody of the national standards of weights and measures, and to verify and certify measuring instruments; and

g) to carry out all other activities relating to standardization.

The functions assigned to NIS cover many objectives which in other countries may be looked after by separate institutions. Larger and more highly developed countries may, for example, have parallel organizations to deal with standardization, testing and analysis, quality control, export and import inspection, and with regulatory control of weights and measures. However, in the VN context of limited scales of operation and scarce financial and manpower resources, the grouping of many interdependent activities under one multi-purpose institution eliminates conflicts and overlapping and seems the best answer to our own immediate needs.

Organizational Structure of NIS:

While VIS is a department of the Ministry of Economy, NIS will be an autonomous agency governed by an Executive Council (see Figure 1). While many standards activities in industrialized nations are private organizations, many in less developed countries are totally under government sponsorship. In the case of Vietnam, experience has shown that a government department in charge of standardization cannot respond to the best interest of growing industry and therefore cannot secure the trust and cooperation of manufacturers. On the other hand, it is believed that a completely private organization will lack funds and authority. The NIS Executive Council calls for the collaboration of government and private sectors to provide the optimum stimuli to the standardization program. The Council members will be selected to represent not only the ministries concerned with standards, but also manufacturers' associations, chambers of commerce, and scientific and technical organizations. On technical matters, NIS will receive guidance from the National Council for Standardization consisting of 40 to 50 members appointed by the Prime Minister to represent all interests in any aspects of standards.

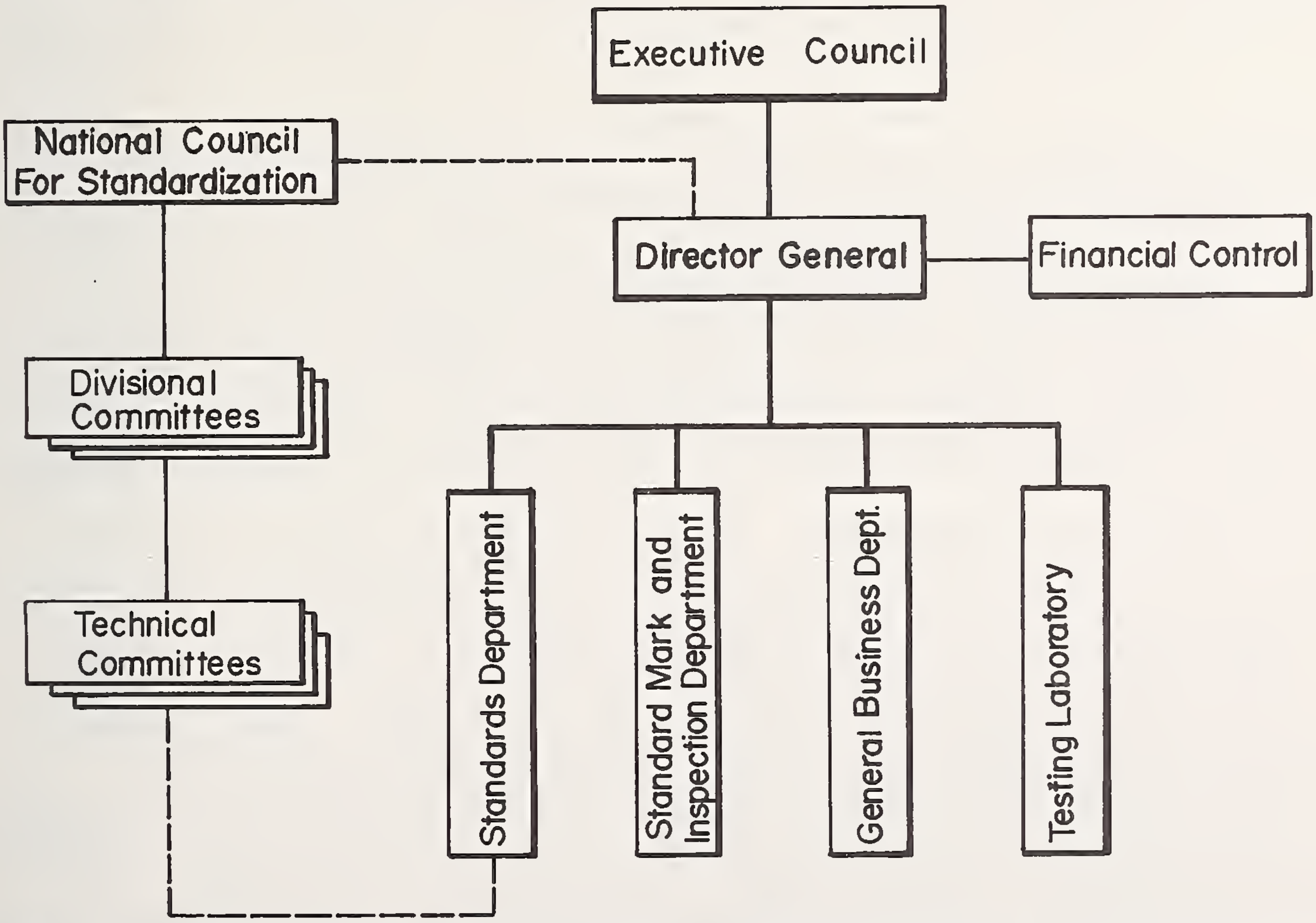

Figure 1. Organizational Chart of the National Institute for Standardization of Vietnam.

Financial Arrangements:

NIS will have its own operational budget and will follow the rules of accounting used by private enterprises. Its income will consist of sales of publications, fees for inspection, calibration, testing and analysis, and contributions from the private sector. However, the income from NIS activities cannot be expected to balance the operational expenses. Financial support from the government will be needed through the years.

These financial arrangements place some part of the burden of raising funds on the shoulders of NIS itself, but they also give NIS more flexibility in its operation to provide services for the immediate needs of the industry, as well as for subsidized assistance to projects having an impact on the national economy and the public welfare. Better working conditions and incentive salary scales can be achieved, to attract capable men to the pioneering frontier of standardization.

IV. Problems and the Future

So far our paper may leave too bright an impression of industrial standards, and the productivity and extension activities in Vietnam. I must therefore conclude with a brief look at problems and the future. All activities have suffered substantially from VN's mobilization of a million man army, but the draft peak is past and we can begin to look for competent or, at least, trainable staff among men who are at the end of some fixed term of duty. Further, with any luck at all, we can anticipate military needs diminishing and a discharge rate that exceeds the draft rate. Also, more can and will be done about the technical training and employment of women in better and better jobs. Training is our greatest need, training in countries more industrialized than our own (the industrial contribution to our GNP is only 10%), or counterpart on-the-job type training in Vietnam by foreign experts. IDC and VIS staff are woefully short of the existing demand for industrial help and industry elsewhere is moving at a rate that widens the gap.

Local conditions forced IDC to attempt to be everything to everybody, but this is changing. A recent decision will shift emphasis in this institution to mounting a development/investment bank based on their present staff and facilities, a bank that will become their core activity with a "beefed up" techno-economic staff for pre-loan investment analysis. This will shift the main burden for productivity/extension services to our VIS, probably before we are ready to cover anything like the present list of services offered by IDC. However, with operation beginning in our own laboratory, we can begin to provide our industry's first and broadest needs in industrial testing. The laboratory is also a back-stop for our expanding technical information services, as well as a limited but useful calibration facility which includes our small instrumental analysis section.

With additional trained staff, with additional training for present staff, and with continuing foreign aid of the type both USAID and NBS can provide, we can begin to offer more in-plant troubleshooting for quality improvement in processes and products, and the quality controls to hold these improvements at desirable volumes of production. There is so much more to be done that we hardly dare look too long at the voids. The need for technical and professional societies is one of these. Also, you may wonder at our ad hoc emphasis on industrial development. What happened to weights and measures? safety codes? infrastructure standards? etc. Well, our preoccupation is turned toward the squeakiest wheel at this point--this may be lack of perspective or it may be just the way things do develop in a growing economy. Certainly many countries, e.g. Korea, came a long way along the path of industrialization before weights and measures, standards of public health and welfare, pollution control, and other "fundamental" standards got much attention. In fact, until a nation has some measure of real independence in its balance of payments (its closure of the import-export gap), even its political stability is fragile, and it can only stand and look hopefully at the future improvement of many "fundamental standards."

I will close with an interesting example from home. For the past decade, a small textile industry grew up alongside our burgeoning big "textile mills." Some of the independent small weavers outgrew handcrafted methods, the products of which had a limited but steady market, by purchasing cheap low quality mechanized looms, the products of early ventures into capital goods production by other somewhat more developed countries. The GVN (Government of Vietnam) permitted them to import their own yarn and even provided them with credit and tax privileges to favor "small industry."

As of today, their products are not worth even the low price they bring on the domestic market. Their volume of production is low and their costs are high. Continuing improvements in quality and increasing quantities of textiles produced by the big mills constitute impossible competition. They have been unable to pay taxes of any kind, to say nothing of their bills for imports. They have no credit for new and better looms. Very recently the GVN cut off their import privileges, a sure death sentence, but what lay ahead except a more painful demise at a future date? They now have mounted a protest, to become another political headache to a government that already has such major ones as war and inflation.

I think it was the great Lord Kelvin who said "things become useful, only as they are measured." It seems that somewhere, someone overlooked measuring the results of "helping" this small weavers' group in Vietnam.

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Paper 4.5 - Standardization in Africa: Problems and Programs

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I. Introduction

Standardization is not a modern invention. It has existed through the ages in some form or another. It is perhaps industrial standardization that has been most recently recognized as an important field of activity for technological progress. Since standards reflect the latest achievements in science and technology it is most reasonable to assume that the rate of standardization characterizes the level of industrialization in a country. Industrial development came late to the African countries and consequently the need for national policy and structure for standardization is relatively recent in the region. However, in most of the African countries both now and during the period of colonial rule, the introduction of standards in various fields of trade and production has taken place on an ad-hoc basis wherever it was felt to be needed. Hence, standardization in the African region has yet to be rationally adopted and developed. While universal standards may be useful, it is essential for the African countries to evolve their own independent standards suited to their special physical requirements and national economic needs.

In the less developed countries of Africa, where industrial development is often dependent on outside assistance, which is usually provided by different foreign industrial groups, the standards used are generally borrowed from more developed countries. Hence, production units tend to adopt the pattern of standardization of different industrialized countries. This creates certain difficulties. First, foreign standards may be inadequate or unsuitable for the intended purpose. Secondly, the importation of know-how and equipment from different parts of the world results in thousands of different types of products and standards, and may lead to waste and confusion. Since countries which have already developed their national standards have tended to develop independently of one another, they have systematically contributed to the creation of "technical customs barriers." These impede the circulation of goods because products intended for a particular market do not meet the technical requirements of markets in neighboring countries. African countries cannot presently afford to be engaged in activities which would foster any such "technical customs barriers", because most of the African countries are relatively small, and the limited demand for each type of product makes it difficult, if not impossible, to develop indigenous production. Consequently, industrial development in Africa may be delayed or made impossible.

Hence, it is necessary for African countries to develop their own national, sub-regional, and regional standards. These would help industrial development from the earliest stages of planning and design of projects, through erection, production, and distribution. Moreover, standardization plays a crucial role in the vital business of export promotion and in ensuring reasonably satisfactory prices. It is also essential for conservation of scarce but available resources and for attaining a high level of productivity, all of which are essential requirements for orderly economic development in the African region.

II. Policy Issues

General Requirements:

The subject of standardization policy in the African countries needs to be treated rationally with a view to obtaining the maximum benefit to the economy of each country and to the region as a whole. In view of the fact that the operation and coordination of standardization activities involves the allocation of scarce financial resources, it is imperative that standards should be developed only in fields and activities which are of industrial and economic relevance at the moment, and in other fields which are likely to be relevant during the period of existing industrial development plans.

The need to develop and coordinate standardization in Africa and, in particular, the preparation and adoption of standards applicable to weights, measures, energy, transport, export products, manufactured goods, machinery, and equipment have been, in general, clearly recognized. Such standardization is believed to benefit:

(i) domestic markets by improving the quality of national production and facilitating its development;

(ii) inter-African trade by facilitating the interchangeability of African products and providing thereby the development of industries and infrastructure on a multinational, sub-regional, and regional basis;

(iii) exports by providing uniform quality of African raw materials and manufactured goods which will have to stand up to international competition, and thereby facilitating a common market in these commodities;

(IV) imports by providing larger markets and thereby generating competition among international suppliers of manufactured goods and capital machinery, leading to lower costs of imported goods.

Standardization tasks pertinent to these policy considerations therefore depend upon a particular subject area and upon its influence on the economic activity of the country or the region. Hence, the priority of the task of formulating a particular standard and the level of the task--i.e. national or regional--must be determined by its contribution to the national economy or to that of the region at large.

National Standards Bodies (NSB):

The principal aim of standardization is to meet the national interest by the stimulus it imparts to industrial development. Standardization equally aims to protect the consumer's interest by virtue of the order it introduces in national production and in national and international commerce. Thus, there can be no doubt about the importance of organizing standards at the national level. Industrial planning, which is accepted by less developed countries as a necessary mechanism for ordered and rapid development of industrial growth, presumes the existence of some standards.

The newer African countries, on the threshold of industrialization and dependent on the export of primary products, have a great stake. The governments of these nations will therefore have to play a major role in standardization efforts. Government financing has mainly to be relied upon for the launching and operation of viable NSB's. In brief, the main functions of the NSB's could be outlined as follows:

(i) the preparation, publication, and implementation of national standards;

(ii) the centralization of standardization efforts in the country through the collaboration of all interests concerned;

(iii) the cooperation with national standards bodies of other countries and in particular its neighbors and countries of the region; and

(iv) the representation of the country in the ISO and IEC.

The physical requirements necessary to run a viable NSB must be catered for right from the beginning. The NSB must be manned and operated by a competent skeleton staff even in the initial stages. From the outset, the staff will have to establish and maintain an up-to-date library. Testing facilities are of fundamental importance to the NSB, since without them the standards will be only "paper standards", and confidence in quality and reliability, which is one of the main objects of introducing standards, can not be built up. Conformity with standards needs to be verified.

Moreover, the NSB must be involved in quality assurance operations through its certification marking schemes. The object of certification is to provide an assurance that will satisfy the user, without further inspection and testing, that the products conform to valid standards that have been defined as precisely as possible by the NSB. Certification marking is of particular importance to the less developed countries of Africa since it ensures a higher reputation for export products in international markets, and higher earnings in foreign exchange through better prices for such export commodities. It also provides the opportunity to evaluate the performance of import materials, in particular capital items, and to check the suitability of their quality levels to the country's physical requirements and economic needs.

Since African countries in their development efforts are confronted with the financing of many development projects which compete for limited available resources, the establishment of priorities on standardization in relation to the needs of the economy is indeed important. If the initial projects are chosen carefully and dealt with so as to highlight the value of standards, and at the same time establish the efficiency and impartiality of the NSB, both material and moral support will be forthcoming to implement a wider program in succeeding years. The main criterion is the economic effect of each project.

Based upon this general consideration, therefore, the standards that need to be adopted and implemented on a priority basis will fall largely into the following categories:

(i) basic standards, i.e. quantities, units of measures, etc.;

(ii) standards for natural products and goods to be exported;

(iii) standards for locally manufactured goods, including food and clothing;

(iv) standard codes for construction, installation, and safety in the operation of equipment;

(v) standards for goods purchased from abroad, particularly capital equipment including agricultural machinery, vehicles, etc., where the maintenance of a reasonable quality level is desirable.

There would, of course, be other standardization fields depending on the economy of a country and its projected plans. The NSB should therefore prepare its annual and short term programs of work after careful consideration of the national needs for creating standards in particular products, processes, etc., and after careful evaluation of the possible benefits accruing to the economy from introducing such standards.

Regional Standardization:

It is an inescapable responsibility of each African country to accelerate its economic and industrial development. In order to do this most effectively, and since regional requirements mainly reflect the common requirements of individual countries, sub-regional and regional cooperation is nowadays becoming a very essential element. In the past, the metropolitan colonial countries imposed their own different national standards. Thus, differences appeared in the systems of weights and measures, railway gauges, voltage for power, traffic rules, etc. Most of the African countries are now free to communicate and trade with each other. For this to be possible, many joint facilities have to be created and some of the existing ones have also to be shared. Furthermore, trade will only be possible where commodities from one country could find market acceptability in another. When such markets have been developed for various commodities, quality and in some cases design standards have to be maintained. Moreover, jointly created facilities and those to be shared will require to be produced or adapted to joint specifications. Exports are a typical field where joint efforts should be made in order to improve their position in world markets. Hence, the need arises for standards to be also developed no longer on the purely national but on a multi-national (sub-regional or regional) basis. This activity may be also conceived and organized as the coordination of national standards where they exist, in order to achieve their sub-regional or regional harmonization.

The limited resources of technical people and funds available in most of the African countries dictate that standardization activity be restricted to the fields of immediate economic and industrial relevance and that priorities at the multi-national level be established. Such a possible multi-national standardization activity may be divided, on the basis of their origin, into the following categories:

(i) based on international recommendations,

(ii) based on foreign national standards,

(iii) based on existing national standards developed by individual African countries,

(iv) developed by the relevant multi-national (sub-regional or regional) standards organization on the basis of the needs of member-countries when there are not any similar standards.

In such regional levels of standardization activities, priority areas have to be analyzed and fixed at first for each country concerned, and common priority areas belonging to the sub-region or region determined and adopted. Due regard must be given to the degree of development reached by each country, the main export commodities, existence of already more or less established standardization activities, etc. Anyhow, considering that individual countries will finally settle the problem associated with the introduction of the S.I. units of weights and measures as a prerequisite for common regional standardization activities in the other fields, the following illustrative subject areas, for which several African countries may have the same interest, could be indicated:

(i) semi-processed and processed staple food and other agricultural products,

(ii) road design and construction,

(iii) road traffic regulations and signs,

(iv) postal and telecommunication systems,

(v) railway design, construction, and operation,

(vi) electric power supply systems,

(vii) sea port and harbor design and operation,

(viii) airport design and operation,

(ix) banking systems, and

(x) foreign trade documents.

III. Programs

Standards:

African countries are presently either engaged in or are in the process of undertaking the necessary ground work in order to pursue the task of preparing and adopting their own national or multi-national standards. Some of the countries such as the UAR, Ethiopia, Ghana, and Nigeria have already established their individual NSB and are elaborating and implementing their own national standards. The other African countries are presently in the process of establishing and strengthening their common standards institutes whose tasks are primarily to prepare and elaborate standards for implementation at national levels.

In the North African sub-region, the Maghreb countries established in Libya their Maghreb Centre for Industrial Development and Research to service the four Maghreb countries, among other things, in standardization activities too. In Eastern Africa, the Governments of Kenya, Uganda, and Tanzania agreed to set up the East African Economic Community under which an East African Standards Institution is in the process of formation. In West Africa, on the whole, standardization has not yet begun in an organized fashion except in Ghana, Guinea, and Nigeria. So far no efforts have been made in the direction of multi-national standardization activities. In the Central African sub-region, there is a Union of Central African Countries (UDEAC) which is intended also to participate and deal with some aspects of standardization work.

Metrology:

With regard to weights and measures, in particular, both the metric and the British systems are in use in Africa. However, several of the countries using the British system are presently changing and are going metric. Most African countries run and operate their own departments or offices for weights and measures. Such an activity essentially includes inspection and verification of measures and measuring equipment against adopted reference standards.

In a few countries such as the UAR and Ethiopia the NSB is engaged in programs of metrology work including the legal aspect of verification of measures and measuring instruments. Such a program in the main consists of:

(i) conducting systematic and periodical calibration and verification of measures and measuring instruments;

(ii) training of inspectors, scientists, and technicians of different laboratories as necessary for verification and metrology work;

(iii) establishing control laboratories and testing facilities for standardization, consisting of: a national physical laboratory, a control laboratory for metrology and material testing, district laboratories, and inspectorate offices.

A quick look at the Ethiopian situation might perhaps provide a characteristic example of introducing standardization, including a metrological activity, in an underdeveloped country of Africa. The Ethiopian Standards Institution (ESI) was created by an Order in September of 1970 as an autonomous body of the Imperial Ethiopian Government in order to introduce and promote standardization and quality control in the country. The Institution is, in particular, charged with the task of preparing and publishing Ethiopian Standards (ES) relating to practices, processes, materials, products, and commodities in the field of commerce and industry and of enforcing the same. By a Proclamation enacted in 1963, the metric system of weights and measures was officially introduced in Ethiopia. In 1967, a set of particular Regulations, which provide for the inspection, calibration, verification, and certification of weights, measures, and measuring instruments by the Inspectorate of Weights and Measures, created pursuant to the Proclamation of 1963, was promulgated. However, the term metric does not directly prescribe the relevant units which should belong to the system. It is therefore necessary to prepare a series of Ethiopian Standards based on relevant ISO Recommendations concerning quantities and units of measure. Consequently, the Imperial Ethiopian Government has already made the decision to transfer the activities of the Inspectorate of Weights and Measures to the Ethiopian Standards Institution in order to combine activities concerning standardization and metrology under the ESI.

IV. Problems and Possible Areas for Technical Assistance

Physical Requirements for Standardization:

From the foregoing discussion, it can be underscored here that the establishment of NSB by African countries is, indeed, necessary. However, certain outstanding features which would constitute constraints in creating and operating a new NSB must be well recognized and be properly catered for from the very outset. Without going into any further details, the physical requirements essential, right from the initial stages, in order for a new NSB to be engaged in standardization work, consist of: a competent skeleton staff, a library, testing facilities, and office premises. Moreover, the NSB must be in a position to effectively participate and provide sound representations in international standardization activities. It is, indeed, important that the NSB influences the initiation of new international standardization projects and, consequently, partakes in the drafting of International Standards and Recommendations relevant to the economic needs of the country concerned. Hence, there is a need for foreign technical assistance in the form of experts, training facilities, and arrangements proper for local staff engaged in standardization tasks. Assistance in establishing new and/or in strengthening existing testing facilities and aids in the establishment of libraries and other physical facilities are henceforth also required in order to promote the efforts of the less developed countries of Africa in their standardization tasks. The magnitude and type of any such assistance will, of course, depend upon the economic situation and the level of the standardization activity already attained by each individual or member country of a sub-region.

Physical Requirements for Metrology:

Here again, the availability of competent staff, which would deal with all the work related to metrology, calibration, and verification of measures and measuring instruments, is essential. Other physical requirements such as Reference Standards, Physical Laboratories and Inspectorate

Offices must also be made available and be properly maintained. The following are therefore areas where urgent foreign technical assistance in metrology activities is required:

(i) training of local staff for skills in inspection and verification of measures and measuring instruments;

(ii) training of scientists and technicians of different laboratories necessary for verification, calibration, and metrological work;

(iii) establishing national physical laboratories and other control laboratories for metrology; and

(iv) establishing district laboratories and inspectorate offices.

V. Summary and Conclusions

In order to speed up their industrialization and development efforts, African countries should evolve and develop their own independent national, sub-regional, and regional standardization and metrology activities that are suited to their special physical requirements and national economic needs. Conscious and concerted efforts are presently being taken along these lines by individual and by groups of African countries.

The new African countries on the threshold of industrialization and dependent on the export of primary products have a greater task of facilitating the development of the domestic as well as foreign market outlets. In these efforts, therefore, the contributions of the NSB's are indeed significant. In order to launch and operate a new viable NSB, all essential physical requirements must be provided for right from the initial stages. Since the developing countries of Africa are essentially faced with limited available resources and technical personnel, foreign technical assistance in metrology and standardization work is urgently required.

In general, the need to develop and coordinate standardization in Africa and, in particular, the preparation, adoption, and implementation of standards applicable to weights, measures, energy, transport, export products, manufactured goods, machinery, and equipment are recognized and felt important. The NSB or the sub-regional standardization organization must, however, carefully establish priorities with regard to subjects requiring standards in relation to the needs of the country or group of countries. The main criterion which has, perhaps, major significance to African countries in choosing new standardization projects, is the economic effect and value of each project.

SESSION 4 - THE DISSEMINATION OF INFORMATION

Discussion

Co-chairmen: Geraldo N.S. Maia and Ismael Escobar

Dr. Ghosh:

Many of the problems and the solutions sought by Mr. Felleke and Mr. Tam are similar to the problems that we have faced in India during the course of 23 years of standardization work. The need for rapid industrialization and for catching up with economic development of the rest of the world calls for foreign aid and foreign technology. This is a must, but may I remind everybody with due respect and humility that foreign technological know-how is a commodity of commerce. Therefore, the country borrowing a technology selects it on a world-wide basis. It is a competitive commodity and perhaps a country obtains the best technology at which it thinks is the cheapest rate. However, there is always danger in buying cheap. Apart from the quality and the nature of the technology bought, it will happen that similar technologies are borrowed from several countries. To remind you of India, our technology in steel came from the USSR, from Germany, and from Great Britain. Unless care is taken to develop a domestic standards institution, this results in the importation along with the technology of a diversity of standards for the same materials, as used by different collaborative firms. Therefore, it is at this juncture that a national body for standardization is most necessary; yet it is more often than not conspicious by its absence at that time. I am very glad to see that Mr. Felleke has emphasized that point. We have established an Asian Standards Advisory Committee to achieve a regional approach to the problems of standardization. Our aim has not been so much to develop regional standards but to give the effect of regional outlook in the formulation of international standards. Perhaps it would be a good idea to have regional approaches as Mr. Felleke has mentioned.

To Mr. Tam I would suggest that it is a very good thing that the Vietnam Institute for Standardization has developed into an autonomous body, because in all countries, whether dictatorial or free enterprise, standardization is developed by the consensus principle. Even in the USSR there is a great deal of consultation before a standard is established. Regarding training I would remind you that we in the Indian Standards Institution have the facility of training foreign participants. We have already trained 37 from as many as 12 countries in Asia and Africa, and currently from the 11th of January, 14 more have begun our course.

Dr. Hiebert:

Let me comment on Dr. Ghosh's remarks concerning the nature of technical assistance. We, at the National Science Foundation, are not in an assistance-giving organization. We are, however, concerned with the scientific community, particularly the academic scientific community, in the USA. We also have an agreement with the AID through which we maintain a small staff in India. We are concerned with the means of sharing know-how and the means by which know-how is transferred from one country to another. The technical communities of various countries have a great deal to gain from interacting with each other, and really the sustaining force for these interactions is not benevolence, but is rather the community of interest and the mutual benefits that evolve from these interactions. I think the Indian Standards Institution profits by having trainees from abroad, and I think every country profits from having foreign scientists working in its various laboratories.

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Dr. Brady:

Mr. Felleke has made a very clear analysis of the problems and needs of standardization in the African states, and presented a definite program for action. I should like to ask him what are the major obstacles to following the action plan that he has outlined, and what sort of time-scale he thinks will have to be followed to establish a well-coordinated regional program in the African countries.

Mr. Felleke:

The policy issues are a matter for political decision. The major step to be taken is the decision by the politicians that a national standards body should be created. Once such a body is created, the provision of the physical requirements and the financing needed for operation will be controlled by the national budget. Some foreign technical assistance will also be required. As far as regional cooperation is concerned, there is a need to establish something like Dr. Ghosh suggested--an advisory committee to investigate the regional requirements for standardization projects. Such regional cooperation will essentially be a clearinghouse for projects concerning standardization and for dissemination of information. In certain instances, effort may be needed for elaborating standards at the sub-regional level for implementation at the national level. However, the big decision has to be the political one--recognition of the standardization effort and the establishment of a national standards organization. As far as the time-scale is concerned, conscientious and concentrated efforts for standardization progress are already being made in African countries. Industrial development is a rapidly increasing sector of the economy; in certain countries it is expanding at about 25% per year. To service this activity you need standards, to plan it you need standards, from design to distribution, so we should proceed with all urgency.

Mr. Arnold:

Let me comment that the regional approach seems logically to be the inevitable approach for the reasons that Mr. Felleke has outlined, not only in Africa, but in Latin America, both in the Andean group and in Central America, and perhaps elsewhere. So this is a very important issue. How do you make a regional approach work? We all know there could be many expressions of political agreement that we should do this sort of thing, but the real test comes when one has to support the activity with funding. How are you funded? Is it totally from the government or is it partly from other sources? Do you have a degree of independence from government support such as Mr. Tam talked about?

Mr. Felleke:

As far as financing is concerned, it is not clear what the purpose of the regional standardization organization should be. Should it be only for status, should it be a clearinghouse for projects or for the initiation of standardization projects, or should it do research? We recently held an ECA-UNIDO conference on standardization in Addis Ababa, and the recommendation of that seminar was to establish an advisory committee to survey the African situation, and to seek the type of organization needed to support such a program. This will be coming, I think; not fast, but it will be coming. Once the membership supports an organization, I think a feasible approach will be to create a sub-regional approach as an interim arrangement. Perhaps for market requirements, we shall need the bigger base for industrial development, and then the need to have regional cooperation becomes inevitable.

Mr. Fontes:

I believe that I could help to answer Mr. Arnold's question. The Pan American Standards Committee (COPANT) is a private body supported by all the national standards organizations in Latin America, and it is operated with the objective of actually writing regional standards on the basis of the contributions made by each national standards organization. COPANT has put into operation a large number of committees integrated on a voluntary basis. They actually prepare drafts of standards, circulate them among the membership, and arrive at Pan American standard recommendations, when these are finally approved and signed by the members. In some instances, contributors are private institutions, but money for this work is provided by the government within the budget of the national institute. The clear aim is to adjust individual national standards to a common standard for all the countries who are members of COPANT. As another example, we have the standardization organization known as the Central American Research Institute for Industry (ICAITI) which performs the job for all the countries that are members of that common market. Up to now it has worked very well. ICAITI has already produced more than 250 original standards with very active participation by these countries.

Dr. Ghosh:

This is another contribution to Mr. Arnold's question. Creation of the Asian Standards Advisory Committee was accomplished with UNIDO/ECA encouragement. This Committee has several objectives. First, to help in the establishment of national standards bodies in countries where they do not now exist. Secondly, to help augment the facilities for those which have already been established but are not fully functioning, and thirdly, to provide a means for consultation with one another. We have already discussed five or six subjects in working groups, each with one of the countries acting as leader. We took up the question of rubber, that of rice, the question of tropical temperatures for testing, and several other matters which were of general interest. Our objective was not so much to prepare a general standard as to develop a general approach to the ISO formulation of international standards. As I will explain in my paper, the ISO recommendations are international, but there is very little contribution to them from Asia, except from Japan, India, and Iran. We want our views to be influential, too, in international discussion when they are topical, dictated by tropical conditions, or by geographical position. In the case of rubber, there is a Rubber Institute, but the grading has all been done in the United Kingdom, where the user interest predominants. In consequence, rubber grading is strongly oriented to the user and not to the producing countries like Malaysia, Singapore, Indonesia, Ceylon, and India. We have tried by correspondence to convey to the ISO a consultative regional view. We have not talked about entering into regional standardization, and the finances so far have come from the governments involved.

Mr. Felleke:

For the record, I would like to say that in the African region the establishment of regional standardization organizations would not mean doing away with national standards. We would still need national standards bodies. The regional standardization organizations would only supplement the activities of the national standards bodies.

Mr. Cali:

I direct this question to the delegates from the less developed countries--no one in particular. What, if anything, is being done in less developed countries to encourage the formation of voluntary associations of related industries to form organized groups to set methods of analysis, establish test procedures, and to recommend specifications? I cite the success of the American Society for Testing and Materials (ASTM) in the USA in helping industry to advance in all areas of standardization. This organization seems to point to a partial alternative to full or complete standards activities by and through governmental process.

Dr. Ghosh:

So far as testing and materials are concerned, the work done here by ASTM is done in India by the Indian Standards Institution, but we have also been thinking about having a National Association of Testing Authorities, like the one described by Dr. Probine. We are trying to have testing so coordinated that the testing authorities are recognized as the best people to accomplish or advise on the tasks at hand. There is no separate body like ASTM, nor is one contemplated in India.

Mr. Bayer:

I would like to add some details about the Central American Research Institute for Industry (ICAITI). It offers several activities to industry such as economic studies. It has industrial laboratories for testing and quality control--all very modest of course. We have a geological division and a standardization division. ICAITI is responsible for standardization for the five Central American countries, and in this activity we operate much as do other countries. We prepare a draft which is sent to each country, to governmental and private enterprises, to industry, banks, universities, and in fact, to all the people that have some known interest in the standardization program. We in ICAITI are also a member of COPANT. Its committees are located in one of the countries that are members of COPANT, according to the facilities of the countries for work in the given kinds of standards. Peru has some committees working on textiles and on copper, Mexico has paper, and Central America has the vegetables and fruit committee. We send drafts to all the countries for their comments, and we attempt to include in our standards all their opinions and observations. ICAITI is supported modestly by the five member countries. Only a part of that support is going to the standardization program, because as I said a few minutes ago, ICAITI has several activities. The same holds for COPANT, which likewise has very modest contributions from each one of its member countries, as explained by Mr. Fontes.

Adm. Maia:

I would like to add a comment to Mr. Cali's question, based on the Brazilian experience with the problem of private standards associations. We have a private national standard association that has worked for more than thirty years. It has several associates both in industry and government. It has not yet done as much work as we really need, and the gap is increasing. I would like to make clear that the work of producing norms by such an organization is quite slow. I do not believe we can tolerate that. We need professional standards writers. At the same time we must not isolate them. So I think that a good half measure would be to have these professionals work on drafts of the norms. They must be capable of obtaining all the technical information from the rest of the world. Then we can let the interested parties discuss the draft with the professional standards writers. With this procedure we should be able to speed up the production of norms. Funding depends a lot on the philosophy of the local industries; if they have money enough to contribute voluntarily, that is fine. If not, I think that the government has to step in and provide the funds. The funds come from tax sources, anyway. I think that today technology is changing so fast that there is no point in waiting for a system that does not work.

Mr. Arnold:

I am glad to hear that the regional cooperation and the hope for financial support are so good. The reason for my question really was the basic reason for our meeting here this week, to try to learn from you in which areas the AID program through NBS might be helpful. For instance, which kind of people might benefit from some elaboration of the basic needs for standards. I would ask you to consider not only the technical people, but also the government planning people, those people who make the financial decisions. Who are the people that would do a better job if they were exposed to this kind of standards and quality control thinking?

Dr. Escobar:

There was a question sheet handed to most of the participants that covers this matter and I am quite sure you will have much information coming from that. (See Appendix 8.)

Dr. Probine:

I have a question that was raised in my mind by Mr. Felleke's paper. He stressed the importance of regional cooperation, and it seemed to me that it would be a little easier to cooperate on a regional basis if there was a good knowledge of the mutual situation in all of the countries that were planning to cooperate. Let me therefore briefly mention the survey which I am doing for UNESCO in Southeast Asia on precision measurement facilities. (See also Appendix 4) It could be useful perhaps to tackle this in other areas. UNESCO has asked me to look at precision measurement facilities in the Philippines, Korea, Taiwan, Thailand, Malaysia, Singapore, and Indonesia. I prepared a questionnaire which I sent out 8 or 9 months ago, and then, when most of the replies were in, I paid a personal visit to the laboratories in the area. I am now prepared to return a draft report to each country to see if it really does represent the situation there, and then finally it will be published. Once published, it will be basically a catalogue of what facilities exist in what countries, in what institutions, and what those facilities are. The questionnaire covers legislation for weights and measures; the field that is covered by each institution in the country; numbers of staff, professional, technical and other; type of buildings that they have; and the type of equipment. I did not want to limit this to facilities for national standards of length, mass, temperature, and so on. I think you have to get a much finer subdivision than this, and I actually used the classification of the National Association of Testing Authorities and of the British Calibration Service. For example, in electrical standards, I asked for information on the range over which a measurement could be made, the frequency where this was appropriate, and the best measurement capability expressed as an uncertainty, in the following areas: DC resistance, DC voltage, DC current, AC current, AC voltage, AC power, capacity, and inductance; also the facilities for calibrating voltage transformers, current transformers, and so on. I filled in a model reply for New Zealand to make sure that the questionnaire was practical, and sent this out with the questionnaires so the people who were answering it would have a model answer to go by. I have been quite heartened by the amount of information which has come back from many countries. I mention it here to suggest that if such information was available for a number of countries in a region, then you would know what was available where. This is the sort of information which can be used as a basis for cooperation. I wonder whether Mr. Felleke would like to comment on whether he thinks this sort of thing might be useful, say in Africa, to facilitate the type of cooperation he spoke about.

Mr. Felleke:

Your experience, Dr. Probine, is really sound and I do not see any reason why we should not benefit from such an undertaking. I think the first step is to collect information. Based on that information, you can plan for developing your activities. We should be grateful if you can provide us with the questionnaire (See Appendix 4) so we can test it on our own ground.

One other comment, Mr. Chairman, is based on the questions by Mr. Arnold and Mr. Cali. A testing laboratory to fulfill the functions mentioned might in the USA rely heavily on private institutions. As far as less developed countries in this day are concerned, it is our ambition to speed up our industrialization effort, and we will have to plan centrally. For planning it is imperative that you have in your pocket the information and the guidelines required. So, if industry is to be planned in consecutive stages then you must provide guidelines for documentation; the standards institution essentially provides these guidelines, so it has to be some type of a government institution. We are interested in the speeding up of this effort. We want to know what kinds of people, and what kinds of departments and how many departments do you need to provide this action--perhaps a ministry for planning, an institute for economics, and so on. The people in Africa must be convinced that the industrialization effort provides the necessary guidelines for rapid standardization.

Dr. Escobar:

We have been talking this morning about the financing for regional standards or regional institutions. The Inter-American Development Bank is a very successful regional institution, but I must offer a word of caution about regional institutions from my experience in many years' work in the central bank for the Central American countries. We have now an international corporation for development and nevertheless we have not been very successful in implementing regionally operative institutions. The common market in Central America has been put forward as an example of regional cooperation, but it is now having major difficulties. Our Bank finds it much easier to help these countries on a national basis than on a regional basis. I am speaking mainly of financing institutions. We have in Argentina the only institution for integration for Latin America and we are supporting it, but nevertheless I must warn our colleagues in Asia and Africa that the path to regional integration as far as economics are concerned is a very rough one. In a critical area like industry it can be very crucial, and they are going to face that problem sooner or later.

Dr. Rohatgi:

It seems to me that information required by technologists and scientists in different countries does not greatly depend upon climates as do other commodities, so that it can be standardized and exchanged at savings to everyone. Facing the explosion in technical knowledge with limited resources, we at the universities have difficulty in keeping all of current research at our finger tips. We would very much like to have an international clearinghouse where we could send a subject title, and get at least a listing of the information available on that subject. Does such a facility exist in the U.S. information service to entertain requests from foreign countries?

Mr. Knox:

I believe it is pertinent to the interests of the less developed countries here that I should expand a bit on the services offered by the National Technical Information Service (NTIS). It started as a vehicle for government agencies in the USA to announce their technical reports. We still publish the announcement journal that comes out every two weeks. It has the abstracts of all of the reports that we collected during that two-week period. A comparable volume is an index volume to all of those same reports. Currently our announcement and collection efforts are being expanded to cover other kinds of agencies, not necessarily U.S. Government agencies. In the 50 states in our country, we have many economic development organizations. They are concerned, as the countries here are concerned, with promoting local industrial development. They need a common mechanism for exchanging recorded information, so we are now working with the association of state development agencies to act as their announcement medium. Their reports then will be announced by NTIS under such topics as urban planning, testing methods, test facilities, or similar topics of interest to economic development. We also act as a vehicle to announce reports generated by intergovernmental bodies. The OECD's road research program reports for instance will be included in this journal before too long. For some years now we have announced and made available the publications of the International Tariff Commission in Brussels, who asked this because of the audience which receives our announcement journal. There are about 8,000 subscribers to that journal, located all over the world. They are primarily in business and in industry, and there are also some academic institutions interested in economic development. If there is some reason for NTIS to provide a similar announcement, indexing, and report distribution function for the less developed countries, we would certainly be willing to give it very serious consideration.

SESSION 5 - PROMOTING MORE EFFECTIVE USE OF SCIENCE AND TECHNOLOGY

Paper 5.1 - Overview - The Role of NBS Capabilities

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I think I easily qualify as the most junior member of the NBS staff, having been in my present role for all of two whole months. So when I review the capabilities of NBS in front of several generations of the Bureau's Directors, you know that I am really sticking my neck out. However, since I have been given the overview role, what I would like to do is to take the opportunity to impose upon this audience some of my own prejudices, and some of my own definitions of terms, so that at least we will be using terms which mean the same to all of us.

The major topic that I would like to address is the effective use of science and technology. To make sure that we are all talking the same language I shall concern myself mostly with the physical sciences. Also I will be distinguishing between science, as an understanding of the natural world, and technology which is more concerned with the actual and socially useful applications of science. We are chiefly concerned about the civilian sector and therefore with the civilian-oriented technologies. As soon as we talk about technologies and talk about them in a civilian-oriented way, we immediately come to the first significant point I'd like to make, and that is that while science is independent of culture, technologies are not. Therefore, when we talk about technologies in different countries, we are really talking about different things. Technology is dependent upon the society in which it is to be used, and therefore there is no such thing as a single global technology. Technologies will differ among nations because social usefulness is different in the various countries. Customs and characteristics are not the same, and I would certainly hope that the more widespread use of technology would not have the unfortunate side-effect of homogenizing the cultures which exist in different countries. I do not think that will happen, but the inappropriate wholesale transfer of technology to very different cultures could lead to that unfortunate result. The rich varieties of culture which characterize the many nations of the world should certainly be preserved. It would be most undesirable, in making technology more available in different countries, if we just go to the countries that have the most developed capability in a particular field and say: "Let us reproduce these capabilities in other countries of the world." I see the task as one that is a lot more creative than that, and the real job is, how do you apply science and develop technology in a way that satisfies the aspirations and the needs of the particular area with which you are concerned.

This is not a simple task and it is not a static task. The needs and aspirations of most peoples and of most countries vary with time; they are very sensitive to the availability of new goods and new services. For example, before World War II there were not many countries that had an identified need for large-scale computing capabilities, yet today this is desired, demanded, and needed by all major industries and government agencies. Of course, there was need for information handling, but this need has taken on a different role and a different magnitude. I am sure you realize that the procedures, the products, and the services of the organizations which have learned to use computing machines have been affected in very fundamental ways. So with other technologies--not only are they culture-sensitive, but they also have an impact on culture, and there is a mutual interaction between the cultures and the technology.

There are a number of technologies which I believe are important to all countries. Clearly, a country needs workable communications systems, workable transportation systems, workable power systems. They also need adequate housing. They need an ability to deliver health services. While these may take different forms in different areas, there is a need for each one of them. However, to look at some other technologies, it is not at all clear that every country needs a space program. It is not at all clear that every country even needs an automotive industry. So while there are technologies which are clearly of importance in every country, there are other technologies which I feel could be skipped by some countries because other nations are putting a lot of time and effort into them.

I would like to discuss in detail a recent example of the development of communication technology in an underdeveloped area. This took place in Alaska, one of the newest of the 50 states. A program was undertaken by the Technical Analysis Division of NBS which was very interesting because it led to some rather significant results. The study was initiated in part by the anticipated sale of the Alaskan communications system to a private organization, and so the State of Alaska asked the Department of Commerce to examine its telecommunication system and predict its future requirements with relation to its economic growth. This to me was an interesting example of the strong interplay between the technological development, the economic pattern, and the geographic characteristics of the country. In particular, the prospective plans on the part of the private organization for making improvements in the system were to be evaluated in terms of the needs of the people of the State. In Alaska, in addition to the relatively well-developed centers of Anchorage and Fairbanks, there are also a number of very small towns and villages in other parts of the State. Although the small communities are relatively poor revenue producers for a communications system, there is certainly a crucial need for their inhabitants to have adequate communications with other areas. It does not appear feasible to use the types of systems which have been used in the 48 states having contiguous boundaries. Several methodologies were developed in this study, and I will mention them as an example of the type of thing which is needed when a familiar technology is to be studied for a new area. A close look was taken at the nature of the future demands for long-distance phone services. This was based on historical data on the long-distance traffic and its relationship to such variables as the population and its economic status. These were projected forward, and a model was developed to make some useful predictions about what kinds of facilities should be used. From these considerations, a technique for judging peakload demand was developed and the circuit requirements were estimated reasonably well. The final package will recommend a telecommunications program for the State of Alaska for the next ten years. As a result of this study, the purchaser of the Alaskan system has proposed a combined satellite and land-line communication system. The satellite component is intended to enhance the flexibility for covering more of the social needs, such as educational television, and the opening of a ground station at Talkeetna is the first link in the system. Part of this study was on the impact of the development of the oil resources on the north shore. Special consideration was given to that and there was also a specific recommendation for the relatively unexplored central region of the State.

I wanted to talk about this particular example because it illustrates many points about a technological application to a relatively underdeveloped area. There was the definition of a problem and the definition of a specific objective to be reached. It required essentially a systems analysis approach. The detailed knowledge of current hardware capabilities are coupled with estimates of the future technology and of the needed software capability. The study brought together a number of specialized areas of knowledge with a number of specialized disciplines. This example typifies the approach that

I feel would be most effective in the forward planning of developing countries. In this approach one considers in a very direct way the social and economic aspects as well as the technical aspects of the problem.

I would expect that NBS will undertake an increasing number of studies which will assess technological needs and then assess means of meeting these needs. There are quite a few capabilities in the NBS for doing this sort of thing, and I think one of the jobs ahead of us is to learn how to do such studies and how to do them well. NBS represents a wide gamut of technical and scientific capabilities and if these can be effectively married to the techniques of operations research and systems analysis, then I think we can be very useful both in the United States and throughout the world. I would like to recommend this approach for the application of technologies in widely different circumstances.

A follow-on to this type of approach might be studies in what we call technological forecasting. In many developing countries, as well as in the United States, there is a strong need for a better ability to predict what the technological future is apt to be like. This is clearly a speculative task, but there is good indication that this type of effort can be of significant value in forward planning. I would hope that this capability could be made available to developing countries as they seek means to develop their own resources, achieve a favorable export-import balance, and acquire part of the world market. The job of forecasting in this area requires a broad scope of knowledge, because the assessment of world markets is by any measure very difficult, particularly where assessment of political stability is required. I do not mean to imply that all these capabilities reside in NBS, but I do indicate that there is the desire to develop them and to see whether they can be applied in a systematic fashion to the needs of less developed countries.

I would like now to mention some of the rather specific areas in which technical assessment and technical forcasting of the type I have been describing would be valuable. Many countries, including the U. S. A., are concerned with how best to develop a national capability for achieving a favorable economic condition. In the United States one of our major assets is the uniformity of the everyday standards of weights and volumetric measures used in the marketplace. In fact, the head of the Office of Weights and Measures said to me a little while ago that the NBS is a spin-off from this Office. However, NBS does not carry out the field inspections which insure uniformity. This is done by the 50 state governments, each having its own agency for that purpose. Officials of these agencies are given much help and guidance through an annual conference hosted by NBS. Here is a case where a fairly simple idea has made a very important contribution to the economic health of the U. S. A. Since there is a uniform system of weights and measures, there is a national market, and that is very important. I have come to have a new appreciation for this after looking at the great diversity of building codes and standards that regulate housing construction in the United States. Here we have an example of the opposite situation, where lack of uniformity has resulted in the inability to develop a national market for new housing materials and new housing technologies. This results in part from the division of responsibility among states and local communities for the regulatory function; there are something like 5000 jurisdictional areas involved. I cite this example from the United States as one in which I feel there is a great need for development. We hope that our Building Research Division will make a direct contribution here through its work on the criteria for structural performance and its evaluation of some 22 types of construction designed by private industry to meet those criteria.

There are many other activities in which NBS has developed procedures and techniques which might serve as a model for providing technical assistance to industries in developing countries. You have heard from Dr. Kushner about the measurement analysis program for mass and voltage. You have heard about the standard reference materials program from Mr. Cali, and about the standard reference data system from Dr. Kushner. Another area in which NBS is starting to move is in the verification of the capabilities of testing laboratories. The ASTM, represented at this seminar by President Smith and Secretary Cavanaugh, has carried on this activity for certain building materials for several years. However, in the very important field of product safety and product performance, there will need to be an expansion of existing laboratory capabilities. The examination of their test procedures will be an important part of this development. NBS has checked reference samples of both cementitious and bituminous materials using its Research Associates to work with ASTM and with the Federal Highway Program. Inspection systems have been set up, and there is a current program to try to develop a valid process for evaluating laboratories and their testing procedures.

Another area of NBS activity which could be of importance to developing countries is its cooperation with the many professional and trade associations which write voluntary standards in this country. ASTM has already been mentioned as one of these. Another organization, which serves chiefly as a coordinator, is the American National Standards Institute. Voluntary standards have played a very important role in the development of the technology of this country. Both NBS and the standards writing organizations might well explore ways in which their methods and documents could be made more relevant to local economic geographic, and climatic conditions in other parts of the world. Assistance of this kind could be extended to developing new tests and new laboratory procedures.

I have been describing some directions in which I hope NBS will take an increasingly effective role in making science and technology more effective within the U. S. A. Perhaps this seminar will leave you with the impression that there are a number of specific areas in which standardization operations in the U. S. A. are well coordinated, and sound technologies are being built on this foundation. To me, it is of greater concern that as a result of meetings and discussions at meetings of this type that there could be new ways for developing the capabilities of NBS, not only for doing work of this type in this country, but also in other countries. There is much to be gained from transferring new science and technology and applying them to a wide variety of circumstances. If NBS develops the capabilities for working effectively with less developed countries, it will have the very important side effect of helping NBS do a better job in assisting the industries of the U. S. A.

NBS SPECIAL PUBLICATION 359 - Metrology and Standardization in Less-Developed Countries: The Role of a National Capability for Industrializing Economies.
Proceedings of a Seminar, 1971.

Paper 5.2 - Applying the Computer

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The first automatically internally programmed electronic computer named SEAC (Standards Eastern Automatic Computer) was developed by NBS. It became operational in 1950, when there were only five or six electronic-type computers in existence in this country, and one or two in England. Following its conception, fabrication and debugging, it fostered some of the earlier applications of computer usage in solving some of the day's problems, whether caused by technology or by man himself, or by his way of life. Some of the early mathematical routines used in modern computer programs were conceived on SEAC with only four thousand words of slow-speed memory. Early work on lens design, skew rays and digitalization of pictures all contributed to the basic foundation of present computer utilization. To my knowledge, ours was the first application of a computer in the resource management area for the Bureau of Supplies and Accounts of the United States Navy.

The greatest factor responsible for the rapid growth of computers in today's world was the introduction and economical availability of reliable solid-state components in the late 1950 decade. In 1950 there were six or eight computers. As of now, if you believe in the reporting system, which is one of our great problems in managing a large resource such as this, the United States Government operates 5000 computers. I do not believe we have an accurate count of the computers in use in all segments of our economy, but it is surely in excess of 30,000. This does not include the new types of mini-computers which are being widely used in laboratories and shops.

In 1965 NBS was charged by the Congress to conduct a program aimed at improving the utilization of automatic data processing (ADP) within the Federal Government. When one starts a program such as this, he usually begins a standardization effort, but a standard for ADP is altogether different from one for measuring the volt or the kilogram. One of the first standards developed was in response to the prevailing question asked by Congress and various other agencies: How do you transfer information from one activity to another without reworking it, since you may not even be able to read the magnetic tape on which the information is placed? To answer this question, we promulgated a standard code which is a binary representation of the alphanumeric symbols and the control signals that one uses in describing data and information for input to a computer system. We have issued 14 or 15 standards to date, which are known as Federal Information Processing Standards.

We do some research and development, but our main effort is in the field of applied development. One recent interesting accomplishment was the development of a computer-controlled scanning microscope which is in use at the National Institutes of Health for cancer cell research. For several years the Center has participated with various research groups in the NBS laboratories in the interfacing of unique equipment with data collection devices, to accelerate the speed, refine the accuracy, and improve the decision process depending on the measurement readings.

The ADP standards activity has been based upon developing a document or a physical item for use in the factory to make sure that products produced met the specifications. Performance measurement has been pursued by NBS for some time. How do you measure the performance of a wall without specifying material and construction techniques? Again, how do you measure the performance of a computer system? It is very important to obtain maximum utilization to tell whether your computer system is doing the job that it is intended to do with the information you are trying to store and manipulate. We have two programs underway in this area. One of them is to measure the performance of time-sharing systems without inconveniencing the user at the keyboard during the measurement process. The other program involves the generation of a library of programs to test the performance of COBOL (Common Business Oriented Language) offered by the suppliers. So far, we have had fairly good results from the measurement of some time-shared systems selected from those now available.

Teleprocessing is a subset of communications that employs a communication network to link computers and users together. It may use telephone lines, satellites, or microwave propagation. In this emerging technology we will find a new wealth of tools to manage the ecology, the natural resources and the general welfare of a population. One example we are studying is the quality and availability of medical information on a demand-access basis, in other words, an immediate response to a request for relevant information. Teleprocessing will eventually provide such services to remotely located medical units, through a network of computers containing medical histories, diagnostics and facts relating to the general health of a nation's people.

What can the computer do for a country relying on electrical power as its primary source of energy? It is obvious that as any country adopts the beneficial features of technology it must acquire an electrical power system. One can use a computer to simulate loads, make predictions, and so forth. A few power companies do have a computer actually in the net to do load switching, but by and large, this is just beginning. Computer manufacturers will be fostering more automatic load-sharing and prediction.

Now, what can NBS do for countries in need of assistance, guidance, and maybe direct hands-on experience with the computer? NBS has a guest worker program wherein a country sends a scientist or technologist to us for a predetermined length of time. The sponsoring country or an international organization or the AID pays his salary and his transportation, and he becomes one of our staff, working side by side with our researchers or analysists for a year or two. Then he returns to his country and applies the knowledge gained during the association with us. This has been a very successful program. The Center has had guest workers from both France and Japan.

We at NBS have already participated and will in the future probably be involved to a greater extent in what I call advisory visits to specific foreign countries. NBS staff members have been to Brazil, Colombia, and Greece within the last two years. In these three countries our main activity has been in providing advice to the governments on the type of computing facility or computer center in which they should invest. Our recommendations have concerned two of the prime applications of a computer, namely, a population census and resource management. These may be considered the foundation upon which to build a more sophisticated system capable of performing detailed analyses for industrialization and market expansion.

I heard one speaker this morning talk about laboratories. Some of the smaller computers and related techniques can assist in improving laboratory measurement programs to achieve more measurements per hour of bench time. If you want to be visionary, you may in the future send computerized information from your measurements laboratory through a communications system back to NBS in the matter of a few minutes. Included in the results will be measurements on standards previously provided, which permit the determination of deviations or errors in procedures. This is a new concept which NBS is investigating and is a possible way to insure improved instrument calibration.

How do you go about obtaining a computer? First off, you should identify a specific task that you know can be accomplished and for which there exists a valid need. The first problem you will face is what computer should I get? We talk about generations of computers--first, second, third, fourth; I think we are somewhere around three and one-half today. The current generation computers are quite powerful machines, containing the new monolithic circuitry in lieu of magnetic cores for storage, and internal logic for parallel processing. You must specify the system capabilities you require, then go to the computer industry. This is one of the hardest steps in the system acquisition procedure. Manufacturers will tend to indicate that they can meet your requirements if you will buy certain trade-offs which may be on either the plus or the minus side. We can provide guidance for writing a good procurement document for the purchase or lease of computer systems.

Time-sharing operation permits a user in a remote location who has an interactive terminal, consisting of a keyboard input and television tube or hard copy output, to obtain access to the information in a computer which may be several hundred miles away. If you are contemplating a system to handle data on resources like those for agricultural production or mineral reserves, should you go to the conventional batch operation with a roomful of tape transports, operators and card punchers, or should you go the time-shared route? In certain cases, you might be better off to adopt the network and remote computer concept, because once you invest heavily in many man-hours of writing programs and organizing data into the format required for the batch machine, you probably will have many problems to solve when you want to convert to a time-shared system in the future. Therefore, you should look at this concept, and I think the computer community will be glad to discuss the pros and cons related to each of the two approaches.

There are other applications of the computer in technology utilization, such as education. This is an important field but it has a long way to go, and for the moment I believe the use of educational TV at the proper level fills the present need. In another three or four years we will see a breakthrough in the use of teleprocessing in the educational process.

There are other areas where one can advantageously use the computer in economic development, such as city planning, railroad locations, communications systems and highways. In this area there is a marriage between the program analyst, the operations researcher and the computer engineer. We provide the tool to carry out analyses and can produce fast valid answers on models this group wants to test for various applications. I believe our Center's knowledge of the field, coupled with the assistance of the Technical Analysis Division in Dr. Willenbrock's organization, can give any country direct assistance in computer selection, data management, and the most suitable type of software. Software consists of two basic languages, COBOL, the business language, and FORTRAN, used in mathematics and science. Also we can assist in advising you on what kinds of people you need, and how you provide training for them when you acquire a system.

So to sum it up, when you decide to go the computer route, pick a well defined project, select the most responsive supplier, make sure that he provides good training, and above all, adequate service and spare parts. There will be consternation unless you are assured of responsive and adequate logistic support to prevent costly downtime until a replacement item is received from the manufacturer.

NBS SPECIAL PUBLICATION 359 - Metrology and Standardization in Less-Developed Countries:
The Role of a National Capability for Industrializing Economies.
Proceedings of a Seminar, 1971.

Paper 5.3 - Problems in Industrial and Technological Research in Ghana

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In the process of advancing from a developing economy to a developed economy, a developing country goes through two noticeable stages. The first is the stage when the industrial processing of its agricultural or mineral raw materials is left to other countries and it imports the manufactured products it requires. The next stage is one in which it endeavors to put a growing proportion of its own labor into the commodities which it exports and, at the same time, meets a growing proportion of its own needs for manufactured products by means of local industry. A developing country endeavoring to improve its economy cannot successfully do so if it neglects the technical aspects of economic independence. It has been generally recognized that sound industrialization must proceed simultaneously with agricultural expansion. Indeed, industrialization has come to be considered almost as an unfailing panacea for the economic problems of developing countries. The late Pandit Nehru is quoted as having said in a speech in March 1953 that "real economic progress must depend on industrialization." Professor Gunnar Myrdal, the famous Swedish economist, says in his book "An International Economy" that "industrialization and the growth of that part of the working population that is engaged in industry, constitute a means of raising national income per capita."

Economic thought within the last decade has identified technological innovation as the single most dynamic factor in the growth of modern economies. True independence of a country, in the present day world, requires a national technological capability sufficient to allow it to exploit effectively all its available resources. To make productive use of the world's technological knowledge, a nation must equip itself with the necessary structures, institutions, and policies. In Ghana, a program of industrialization has therefore been embarked upon with a view to solving, in particular, the country's foreign exchange problems. Two main areas of activity that have been broadly identified in this regard are the production of import substitutes and the manufacture of products for export.

Industrialization needs three basic elements, namely, studies and research (technological and socio-economic), decisions from a proper authority (public or private sector), and implementation of these decisions. Research, scientific, technological, or socio-economic, is an essential instrument in developing the human and material resources of a nation. In particular, industrial research is of basic significance in laying the foundation for a sound industrial base and in accelerating the economic growth of developing countries. It is an effective tool for obtaining and maintaining a high level of economic development. Technological innovation is imperative if a nation is to raise its standard of living and keep moving its relative position in a technologically advancing world, and it is on industrial research that innovation in industry depends. It is only when industry recognizes this role of research, and begins to use research, that it will be able to grow rapidly and contribute effectively to overall national economic growth. The basic purpose of industrial research is to provide industry with a technology which is responsive to local factors of production and to the peculiarities of the market. Industrial research is therefore vital for sound industrial development. It enables industries to do better at what they are already engaged on, and it provides information

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for embarking on new activities.

A brief statement in general terms on the functions of industrial research will facilitate the appreciation of the problems involved. The functions of industrial research and development include discovery of new products; prospecting for and utilization of raw materials; development, improvement, or adaptation of production methods, techniques, processes or equipment; pilot-plant trials; formulation of standards; quality control; market research; feasibility studies; design studies; and productivity studies. Industrial research should cater for all types of industry, regardless of size, public as well as private, using such different methods of approach as are necessary. It should develop technologies best suited to local needs and conditions.

Attention should also be paid to the whole range of activities by which scientific, technical, and economic knowledge may be transferred into industrial practice to bridge the gap between industrial research and development, and the actual utilization of the results thereof. Often the rate at which research results are applied by industry is slow. This may be due to several reasons, among which are the lack of effective communication between research and industry; the lack of technical manpower; and economic as well as procedural difficulties. With a view to the speedy application of its results, industrial research should not be conducted in isolation, but in relation to the practical needs and requirements of industrial development. The research organization can only meet its responsibilities towards the nation by being fully associated with national industrial development objectives. An important function is therefore to provide close contact between the problems of commercial production and the conduct of industrial research, and to promote the closest cooperation between research groups all the way from laboratory to pilot-plant operation and on to commercial production.

During the past decade a series of symposia, both regional and interregional, have been held under United Nations sponsorship on the subject of industrial research and development. Notable among these are the Inter-Regional Seminar on Industrial Research and Development Institutes in Developing Countries (Beirut, Lebanon, November-December 1964), Symposium on Industrial Development in Africa (Cairo, January-February 1966), Conference on Industrial Development in Arab Countries (Kuwait, March 1966), Latin American Symposium on Industrial Development (Santiago, March 1966), and the Workshop for Managers of Industrial Research Institutes (Athens, July 1967). Throughout all these seminars it was recognized that most of the industrialization of the developed countries could be traced back to technological research; and it was generally agreed that for successful industrialization it is essential that even a small nation have at least one institute with laboratories designed to serve industry in general. Ghana has one such institute within its Council for Scientific and Industrial Research, CSIR, namely, the Institute of Standards and Industrial Research, ISIR. This Institute works in three of the four main areas that usually characterize industrial research institutions--namely engineering sciences, physical sciences and techno-economic sciences.

The more significant problems that have been encountered in the execution of industrial and technological research in Ghana may be listed under finance, manpower, and equipment. Finance is the most dominant, and has an impact on all the other problems. The main sources of funds are government and industry. In the circumstances of developing countries at virtually the initial stages of industrialization, it can readily be appreciated that industrial and technological research cannot expect much financing from industry. In all the UN-sponsored symposia mentioned earlier, it was the consensus that in all less developed countries, governments should accept the responsibility of providing adequate financial support on a long-term basis to their industrial research institutes, so as to ensure continuity in their work and to permit them to fulfill their basic objectives. The acceptance by government of this responsibility will no doubt stem from a recognition by government of the important role of industrial and technological research in the economy of the nation. Earlier in this paper it has been shown that industrial and technological research is a prerequisite for sound industrialization. The role of industrialization in raising the living standards of the people, increasing productivity and ensuring stability in the national economy has also been stated. It has been shown that real economic progress depends in a large measure on industrialization. It can therefore be said that the benefits of industrial and technological research to the nation are clear, and government might not find it difficult to recognize this. I would indeed say that investment in industrial research is in fact a sound investment in industry and even in the future of the nation.

As to manpower, these industrial and technological research and development institutes must be staffed with the most highly qualified personnel at all levels. An institute cannot function successfully with a staff inferior to that of the enterprises it expects to advise. Skilled manpower is in short supply. In Ghana, as is common in developing countries, skilled manpower is needed both for the adaptation of imported technologies, and for the establishment and operation of local technologies.

Here I might mention a fact that is not often appreciated. Foreign technology may be abundant. But the form of the technology used in richer and more technologically advanced countries--with their better supplies of administrative, scientific and technical manpower and capital--is often inappropriate. Much foreign technology requires adaptation to suit local environment--a fact which clearly illustrates the need for on-the-spot organized research and development.*

To keep the correct emphasis in research and development institutes it is wise to employ not only scientists and engineers to supply basic information and to do technical development, but also social scientists to analyze costs and markets and to find appropriate means of selling the research and development outputs. Applying science for growth requires attention to the two faces of innovation--technical and social.

Closely associated with the manpower problem is the lack of technological "know-how" and industrial experience. A number of steps are usually taken towards solving the problem posed by manpower shortage and its associated difficulties. These include accelerated training programs for indigenous personnel and the importation of qualified foreign staff. In the importation of foreign staff, difficulties are sometimes experienced in obtaining experts of the type and with the qualifications and experience required, or in obtaining them within a reasonable time to meet the demands of the program. Direct recruitment in this regard is hampered further by reason of unattractive remuneration and other service conditions. Several schemes of bilateral and international technical assistance have been launched with varying degrees of success. In these schemes emphasis has been laid on assistance in the initial organizational stages, counterpart training, and the provision of individual specialists for specific work. The great value of external technical aid is appreciated. It should, however, be recognized that external technical aid can not be a substitute for the development of local staff. Serious attention should therefore be paid to training programs both internal and external for indigenous personnel. Such training programs are of extreme importance and should be strengthened where necessary.

Stanley Teele of Harvard University (Division of Research) in his

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* Editor's Footnote: See Paper 2.4 for a fuller treatment of this topic.

publication entitled "Technological Planning on the Corporate Level" states: "I think that the premium on imagination, on flexibility, on the capacity to deal with questions that have never been asked before, will be very much more substantial than it has been in the past. I think that the capacity to deal with new knowledge effectively, new knowledge that is piling up at a rate that is hard to exaggerate, is of utmost consequence. It demands the capacity not only to acquire and use knowledge, but also to discriminate carefully with respect to what does not need to be acquired and what should be avoided." The manpower for industrial and technological research should possess these qualities, and it would be wrong to assume that any science graduate is automatically a potential research man. The type of scientist acceptable for research would be an honors graduate in those disciplines most required, namely, chemistry, engineering, or physics, with a post-graduate degree (or training by research in an applied scientific field) and at least one to two years in an industry of specified specialization or in an industrial research institute. It is necessary that the applied scientist should have had prior university training in research methods and techniques. It is also necessary that as soon as practicable after the acquired background in a university atmosphere he should be exposed to the industrial disciplines of time, money and reward.

Problems of equipment are those of finance, procedural delays associated with purchase, selection of the right type of equipment, adaptation of equipment and local instrumentation and improvisation. In the equipping of laboratories and the setting-up of facilities for research and development, it is also necessary to include adequate repair and maintenance facilities, workshops, and skilled technicians. These pose additional problems of availability of spares both in quantity and in time. The experience of similar research institutions in countries with reasonably similar industrial conditions can be useful in solving some of the selection and adaptation problems connected with laboratory equipment and facilities. The proven benefits of standardizing in plant and machinery can also be brought to play on the problems of variety and availability of spares.

A real problem, however, exists in various laboratories with regard to the maintenance, repair, and replacement of scientific equipment. This is due to two main reasons: the difficulty of obtaining spare parts quickly (due to shortage of foreign exchange) and the paucity of instrument technicians. Serious attention is therefore invited to the need for local instrumentation and improvisation. The habit of pursuing the line of least-resistance, by studying all available manufacturers' brochures or shopping all round the manufacturing world in order to select and purchase even the simplest requirement in laboratory equipment, needs to be drastically modified. I have in mind the needs in Ghana of the Glass Blowing Unit within the CSIR; there is also the Instrument Calibration Unit in the ISIR also within the CSIR; there is the Science Workshop at Legon. A recent survey has shown a few other facilities elsewhere. A determined effort should be made to weave these into an "Instrumentation Service" with a central point for receipt and administration of requests. This will provide services in research apparatus manufacture, the design and manufacture of prototype scientific apparatus, the training of instrument technicians, and instrument repair. There can be no doubt that this will be of practical benefit to science and technology in the country.

In conclusion I would like to refer to the Inter-Regional Seminar on Industrial Research and Development Institutes in Developing Countries organized by the United Nations Industrial Development Organization (UNIDO) in Beirut, Lebanon, November-December 1964, which I attended, and to invite active attention to the recommendations made by that Seminar, which I quote hereunder:

"1. Developing countries should take the necessary steps as soon as possible to establish appropriate industrial research and development facilities or to strengthen existing ones on lines most applicable to the practical requirements and national development goals;

"2. With due recognition of the importance of basic research, the emphasis of these research institutes should be upon applied research and development programmes fully oriented toward the needs of industry;

"3. Industrial research and development institutes should be given the greatest possible autonomy to enable them to function in the most efficient manner; without the inhibitive influence of ordinary government procedures and restrictions which are generally incompatible with the needs of successful research operation;

"4. Personnel engaged in research and development should be rewarded on a scale that will at all times enable the research institutes to engage and retain the best personnel to be found and to ensure their complete devotion to the work;

"5. Government of developing countries should be called upon to accept full responsibility for the provision of adequate financial support on a long-term basis to their industrial research institutes to ensure continuity in their work and to enable them to fulfill their basic objectives;

"6. Equipment and supplies of all kinds needed for industrial research should be exempted from customs duties and taxes, should not be subject to import restrictions or licence, and should be allocated adequate foreign exchange in all cases;

"7. The United Nations should enlarge its programme to assist developing countries directly in (a) on-the-spot studies of industrial research and development organizations or needs in individual countries with a view to establishing and/or strengthening such institutions and their operating links with industry, (b) the implementation of such studies, including the establishment, equipping and operating of such institutions and the training of industrial research personnel;

"8. The United Nations should study, keep under review, and disseminate information on the organizational aspects, functioning and programmes of the various industrial research and development institutes and similar organizations or departments, with a view to facilitating the interchange of such information between different countries. The United Nations should also assist in the interchange of visits between industrial research personnel in different countries."

Paper 5.4 - Implementing Metrology through Operations Analysis and Systems Engineering

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If we accept that metrology is the art or science of precision measurements, then do we have a term for injecting metrology into the functional world? I think we do in the one word, "calibration."

A calibration system is an orderly set of rules and procedures that provide the assurance that metrology is being properly implemented and tests are certifiable through higher levels of accuracy to your national standards. I will assume we are all aware of the need for national standards.

Now that we have a term for implementing metrology, what is the significance of operations analysis and systems engineering? When we calibrate, we are accomplishing a test to validate the performance of the unit under test. This can be done as a separate check, or as a regular step for controlled maintenance. However, no matter how it is done we want top accuracy at lowest cost, i.e., an optimum system. One widely accepted approach to problem solving is known as "system engineering." The idea is to look at the whole system at the same time one is looking at each element of which it is composed and at those with which it interacts. This system engineering approach has in recent technological times allowed us to achieve optimum solutions to highly complex and involved situations. The other tool is operations analysis, which scientifically and/or mathematically is addressed to the needs or goals of the problem in context with all of the elements that are contributing to or detracting from these goals.

How do these techniques pertain to metrology and to calibration? The United States has a highly developed national standards system. It also has a number of very complex and extensive calibration systems to bring the national measurement references to the user. Our national standards and the related calibration systems have evolved with user technology advances, and were built piece by piece as needs arose. The system engineering approach was not used, as such, from the outset. However, we do call upon operations analysis from time to time in an attempt to look at the picture with optimization as a goal.

Now, let us return to the theme of this symposium, which pertains to metrology related to less developed nations. Here we have a situation where technologies have been developed by the industrialized nations, and a less developed nation is trying to enter this advanced world. There is little time to evolve a system. An emerging nation already has definite metrology needs since it is probably operating jet aircraft, manufacturing complex electronics, involved in extensive trade with the world, and maintaining an effective military establishment with modern weapons. We at Hughes Aircraft Company, who are involved with calibration programs, think that such a situation demands the operations analysis and systems engineering approach. We feel that this approach not only achieves the desired results earlier, but saves money and provides for efficient expansion as new technological demands are imposed on the system.

Let us discuss some specifics of this approach. The key to optimization is a detailed analysis of the working level needs. These realistic needs are traced through various levels of a conceptual calibration system to the national standards. At each level of support in the conceptual system, an optimizing process takes place so that when the process is complete, the entire system is structured in an optimum manner. All of the working level needs will be satisfied with a minimum of equipment and personnel, and measurements will be certifiable regarding traceability to the national standards.

In performing this task, systems engineering techniques must be employed to consider such things as geographical densities, facilities, equipment, spare parts, repairs, procedures, controls, organization, workload scheduling, recall system and many many others.

One consideration, which lies on the periphery of systems engineering, is an optimum implementation schedule. For reasons stated before, a newly developing nation emerges relatively rapidly and the potential for waste and loss of efficiency is great. Precision measuring equipment is expensive, and one or two bad purchases that do not materially contribute to the workload will waste limited funds. Also, trained personnel are scarce, and if not properly utilized they also will be wasted resources. For example, you could establish a beautiful set of national standards comparable to the best in the world, but you might not have a real basis to determine where the reflected measurements will be ultimately used; or we might establish very sophisticated and expensive measurement instrumentation today in a location where the practical requirement for its inherent accuracy will not exist for 10 years. Only an economic analysis of the needs and costs can determine the wisdom of the decisions. Operations analysis provides the required visibility.

System engineering techniques will provide answers to many other questions such as: What level of training can we expect to achieve with local personnel? Will this level of training affect any equipment selection decision? If we identify the level of training, what is the overall level of competence that we can project and are test procedures written to this level? If the level of competence is lower than similar countries or systems, can we select different equipment, or can we implement handling, processing, or test procedures which will compensate and thereby achieve the same results? Will the level of competence allow the same person to repair and test? Does the workload distribution lend itself to this mode of operation? Can we accomplish repair if spare parts are not readily available at the location under study? If not, should we test only at that station and repair at another operational level?

These questions go on and on; however, as a result of systems engineering, the interaction which is apparent above is systematically and efficiently optimized for the concerned nation. We believe that there is no one metrology/calibration system that is good for all people or nations. Each nation has different goals, requirements, constraints, and financial status, so that a metrology/calibration structure for each must be optimized to these differences.

The last major facet to which this paper is addressed is the means and resources necessary to accomplish the operations analysis and systems engineering. First, and absolutely necessary, is a total awareness and knowledge by the performing organization of test and measurement equipment support characteristics and requirements, from metrology to repair. Second, the specific staffing for the job. We find the best combination of personnel to be a staff of calibration specialists working with operations analysis and systems engineering experts. The operations analysis and systems engineering experts apply proven techniques to the problem-solving task. The calibration specialists, using these techniques, apply their near-instinctive knowledge of measurement systems, requirements, and equipment to the workload requirements data and arrive at practical answers in a far more efficient manner than by any other techniques we have explored.

Very few people are really up to speed in these concepts and the expert staffs necessary to efficiently perform calibration system development are hard to find. However, the concepts are sound and should not be ignored in the process of developing optimum metrology/calibration structures for the nations of the world.

The vital points of this paper are again stated for emphasis. We must keep in mind, throughout the whole process of developing a system, that the users' needs are to be met so that we do not establish a fine standards laboratory with no meaningful connection to the real workload. We wish to minimize costs, yet meet the needs. We must assure proper staffing and management of the system to keep it functioning. We need a totally optimized metrology/calibration system consisting of many diverse yet interacting components. The most effective tools to accomplish the task are the principles and techniques of operations analysis and systems engineering. When these are executed with diligence and experience they will yield the desired results to provide another firm foothold on the ladder of industrialization and emergence into the technological world.

Paper 5.5 - Product Development and Market Research

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At Ford Motor Company I am responsible for coordinating a world-wide marketing research effort that encompasses inputs to our distribution planning, market planning, marketing planning (advertising and sales promotion), and product planning efforts. The latter item includes new as well as improved product offerings.

To start with, you might say that the elements that precipitate or that underlie product development are to a great extent socio-economic changes. These generally create changes in needs, wants, and life styles of the people. Usually this type of information is sought from government sources. The kinds of information we seek are:

Economic data such as: total national income, TNI per capita, gross national product, GNP per capita, GNP average annual growth, and consumer price index.

Demographic data such as: population, births per 1000, infant mortality, life expectancy at birth, annual rate of population increase, population growth by age segments, percent male versus percent female, average size of family, distribution of population by geographic areas and by city size, population density, working age of population, workers in manufacturing or other employment statistics, rate of unemployment, income distribution, education levels of population, and percent illiteracy.

Language and religion such as: religious distribution and ethno-linguistic distribution.

Consumer expenditure information such as: total expenditures, food, beverages, tobacco, clothing and personal effects, household furnishings, personal care, health, transportation and communication, and fixed capital formation.

If we can actually get all of this information we normally find that the nation is not just emerging, but has emerged. Many times we fall far short of this goal and have to resort to our own data collection and educated guesses by our own personnel and by such groups as the Economists Intelligence Unit.

One must always remember that before you have a market you need: people who have a need either expressed or latent, who have money to buy, and who have a desire to buy. You have got to think about the market first (the user and his needs), then decide if the product you want to offer is unique, salable, and provides a benefit at lower cost. Because the risks in marketing new products, whether in the United States or elsewhere in the world, is so great, marketing research is needed in an effort to reduce the risks involved.

As a result of reviewing all of the available socio-economic data for the market involved, our product and market planners attempt to decide what products we have available, and what products that we can develop would have high potential for acceptance in the particular market. Sometimes we can do this from existing data and on other occasions we find it necessary to generate our own data by way of a representative cross-section sample survey. Assuming for the moment that sufficient data exists, we attempt through our research to determine as much as possible about the potential market for our product class, such as:

(i) How big it is in terms of volume; initial market, and long range market.

(ii) Who would be the market--sex, age, marital status, education, income, home ownership, etc.

(iii) Where might this market probably be--region, city size, urban/rural, city versus suburbs.

(iv) What are the present buying habits, usage habits, and attitudes regarding products similar or comparable to the new product--who will buy it?

(v) What do customers like and dislike about the generic type of product or whatever they currently use?

(vi) How can improvements be made in generic types of product or what they are currently using?

(vii) What are their purchasing habits of similar type products, if such products exist--where purchased, how often, how many each time, price paid, etc? What are usage patterns--purposes used, amount used, and when used (seasonal patterns)?

(viii) What is the competition for the new product?

(ix) What habits or patterns must be changed, if we are to gain acceptance for a product such as we could produce?

If the potential appears to be large enough to warrant further investment we then proceed to develop ideas that will meet the market's needs. When these ideas are developed our management committees screen them and those that survive are then subjected to pre-testing. Remember these may be, in some instances, just rough ideas or broad concepts. This pre-testing of new ideas can be done by presenting the ideas or concepts to the company's own marketing and sales personnel and to other knowledgeable people who have some general feel of the market. However, whenever possible it is preferred that concepts be tested among potential customers. In testing a concept, the potential customer should clearly understand the functions, uses, and possible situations for the product and, wherever possible, aids should be used that will graphically illustrate the product. The product should be compared with other existing products that are currently performing the same or similar types of functions, and the price or price range for the product should be clearly understood.

This type of product concept testing enables the product planners to make easy judgments before too much is spent, to reduce the number of concepts that are to be refined or improved upon, and in many instances, may even lead to new ideas. Early concept test results should be treated as tentative and inconclusive. After this type of research is conducted, the concept may be rejected, may be accepted, or may be accepted pending further refinements. If the concept warrants further development then it may go to the stage of prototype testing which involves actually building the product and putting it into a limited or full-scale use test. This latter type of research provides the manufacturer and the prospect an opportunity to evaluate the product under actual operating conditions.

Weaknesses may be discovered that can lead to redesign or else clues may be uncovered that will lead to better marketing, distribution, and servicing opportunities and requirements. These types of tests are normally conducted on a rather broad scale among a cross section of potential users. The methods employed in the survey technique are personal interviews, telephone interviews where and when available, mail questionaires where and when available, and focus-group interaction sessions. The latter technique is one where groups of people sit around a table and have an opportunity to discuss the product and all of its ramifications. It is recognized that many of these techniques are not available for use in the emerging nations. However, to the extent that they are available, they are recommended for use.

In terms of product development one should also consider the importance of the name of a product since a name can act either as a deterrent or as a positive communication. A name that is meaningful, that sounds well and that communicates well creates an expectation by its imagery. It should look good in print. It should sound good when said, and it should be suitable for the product it is going to grace.

Research should be conducted also on the package or the design of the product since these, too, are communicators of what the product is and can do. The package should be both attractive and functional for the many uses to which the product will be put. The shape of the package, the color of the package, the package material, and the labels all play a very important part in selling the product. These, too, can be tested by the survey method.

Once a product is decided upon and introduced, continuous follow-up research should be conducted so that management may decide the extent to which success has been achieved. This research may take the form of sales analysis and further surveys of the market. What we attempt to discover here is: the volume achieved, share of market, user characteristics, consumer opinions of our products and competitors, repurchase rates, dealers' opinions of our products, how product is being used, and advertising and sales promotion effectiveness.

Lest I have made the marketing research process appear too simple, let me state that it would be foolhardy for me to attempt to teach all of the techniques in a fifteen minute period. These techniques usually employ many refined statistical techniques in sample design and analysis, the know-how of the psychologists and sociologists in the design of the questionaire and the use of various scaling techniques, the expertise of the computer people in ordering and tabulating data, and the knowledge of marketing experts and economists in the analysis of the report. These skills are sometimes to be found in the emerging nations, but most often are brought in from the outside.

The problems faced in doing market research in the emerging nations may have to do with: lack of research facilities, little sophistication in techniques, cultural differences, high levels of illiteracy, lack of census data from which to draw samples, economic differences--high proportions at subsistence levels and difficulty of finding middle or upper income families, heterogeneity of population and difficulty of reaching all, multiple languages and dialects, and geographical differences.

Although there are many problems to overcome, there is no doubt that the use of market research in emerging nations is on the increase. I cannot help but believe that the trend will continue, because of the vital role that it plays in bridging the gap between those who constitute the market for products, and those who wish to capitalize the unfulfilled needs and wants of people.

Discussion

Co-chairmen: René Schmied and William T. Cavanaugh

Mr. Nigro (In response to a question raised by Dr. Branscomb):

A smaller country, or one that does not have the sophisticated communication system that we have here, will with the advent of teleprocessing be better able to utilize computation facilities. To have a good teleprocessing system, you need several computers located in different geographic areas. One of them may store financial and economic data, another might have demographic data, another might handle scientific work in problem solving or analysis. Each one should have a group of people trained in such specific types of programming. A good communication system would link together the network of computers with the terminals giving the user access to the entire network. I believe such a system will be the coming thing. I think that certain areas right now could probably benefit by starting out on a small scale. That is what I meant when I compared the large batch type operation in one location where everybody brings their cards, with the on-line time-sharing system which implies teleprocessing. I think the second question was, can we in the NBS Center for Computer Science and Technology provide any meaningful assistance? The answer is, yes.

Dr. Branscomb:

I wonder whether the uses of computers which are most attractive to us are in fact totally irrelevant to countries where capital is short and labor is plentiful. The replacement of clerical workers, for example, which is a common objective in this country, may not be useful in other places. I would be happy to have somebody in the audience tell us how they think data processing technology can be used effectively in the less developed countries.

Mr. Lovejoy:

About a year ago I was talking to the Director of the Computer Science Institute in New Delhi. They then had about 200 computers in India and they were using them about 20% of the time. What they were proposing to do was not exactly teleprocessing, perhaps because the network Mr. Nigro mentioned was not developed. They were setting up five or six regional centers based on regular pickup collection of punched cards for computer entry, which for most purposes would be quite adequate.

In answer to Dr. Branscomb's second question, I am afraid it is pretty much as he said, that maybe the 50,000 clerical workers processing financial or economic data would be put out of work by the introduction of a computer, adding to what is already an unemployment problem.

Mr. Nigro:

Just because you bring a computer into operation does not mean that you lay off workers. In fact, if you look over the situation in this country you will find that with the advent of the computer we have developed a whole spectrum of new talents. We have also raised some people from the unmeaningful tasks of sweeping the floors or grubbing in the cotton fields to fairly respectable social positions such as systems operators, journeymen programmers, and as Mr. Lovejoy says, card punchers and messengers. In general, a computer does quite often raise the level of employment.

Adm. Maia:

NCI in Brazil has been using computers since 1960 and we have now around 600 computers installed. As always happens, in the first year we had a lot of idle time, but just before I left home I saw a survey which showed the range of utilization was from 200 to 500 hours a month, which is not too bad. This development has brought a lot of help in the management of enterprise, and is as important as the technological aspects of industry. I think that no serious unemployment was brought about by the computer installations. We relocated the people. Teleprocessing is a problem with us, but not because of the communication lines between cities, but mostly because of the local lines.

Mr. Cali (to Mr. Marshak):

How does market research take into account questions of the social concerns and expectations of a given country? Is this considered as given? Do you ask questions to determine what the concerns or expectations may in fact be?

Mr. Marshak:

We are definitely concerned with the social goals and we do ask questions. These are part of the studies that we do in all the countries that we enter.

Dr. Tabor:

When Parkinson produced his famous law, a lot of people seemed to think that he had his tongue in his cheek. My own view is that he is probably the most perspicacious person in this century--you all know his famous edict about work expanding to fill the time available for its execution. Since then there have been many copiers of his style and one of the recent ones says that traffic expands to fill the space available for it. I believe that this is very true in relation to the traffic of telecommunications. I know that Israel recently installed a submarine cable to Europe with a certain capacity for calls, and now half a year later it is already overloaded and has to be rebuilt. The reason I mention this is two-fold. In the first place, I think it is a warning to Dr. Willenbrock in connection with his technological forecasting. You can look at the rates of growth of a particular activity and project it for another two years, assuming the same rate or a slightly higher rate or a lower rate, but if you do not take into account Parkinson's law you are going to get into real trouble. In the less developed countries there is a teleprocessing bottleneck in the communication network. If you introduce teleprocessing you will without a doubt overload any telecommunications system that is currently available.

Dr. Ghosh:

In India the question of computers is connected with unhappy labor unions. They say: No computer because it means unemployment for several thousand people; we are no longer interested in any argument; if you have computers, face a labor strike.

Dr. Rohatgi:

Computers certainly are helping in scientific research institutions, although as Dr. Ghosh points out their introduction may cause unemployment in business organizations. In a scientific research organization you are not displacing anybody; the student had to do his calculation anyhow. The Indian Institute of Technology of Kanpur provides service to a number of cities nearby, and many people come and stay at the Institute for a couple of days to punch the cards and obtain their outputs. In India the pace of life is reasonably slow and telephone communication is not the best. It is easier for them to come and stay at Kanpur to do their computer work and then to go home.

Mr. Cavanaugh:

The conversation about displacement of people sounds much like many discussions in which I used to participate 16 years ago. Let me report the fact that in the most computerized nation in the world, we have the greatest shortage of clerical personnel of all sorts right now. The logic of displacement has not worked here at all, and apparently it is not working in Brazil either.

Mr. Arnold:

It strikes me that we must once again recognize the spectrum of development, and that general remarks are always inappropriate from one end of the spectrum or the other. With regard to one end of the spectrum, if a country has neither a calibration laboratory nor a computer, I have a hard time seeing that they would place the priority on a computer. If they are concerned with a product, an operation, or a process the first priority should be the calibration facility. As Mr. Nigro said, they should start out small, pick a specific area where a computer can solve the problem more efficiently, acquire information as needed for planning, and try to make jobs for people that are going to be operating the computer.

Mr. Felleke:

I am somewhat confused by the observation presented last night by Dr. Tabor and also by Mr. Russek concerning the need for a precision capability for metrology work. In the Ethiopian Standards Institution we are engaged in legal metrology, and we have to support such an activity as precision measurements, but it seems that in the recent discussion such a capability is being called unnecessary.

Mr. Russek:

How far must you go to be legal? If your legal people want to have 99.9999% accuracy then you have a problem. I think you must revise some of the legal definitions. There has to be some acceptability as to what level the application requires. I call it optimization.

Mr. Cali:

May I make a further comment on exactly this point? We have a law on the books that says that customs duty on fluorspar imported into the USA will be assessed at 97.0% and there is no definition in the law of plus or minus anything. Within the past five years this has cost fifty-three million dollars in litigation. I would urge all of you to make sure that your statisticians sit down with your legal people.

Dr. Branscomb:

I think it is essential that one look at metrological requirements from a completely utilitarian point of view. It is necessary that legal restraints follow that analysis and not precede it. Industry needs metrology only to the extent that it is absolutely necessary to ensure the production line functions and for the product to meet the marketing specifications. In that sense I see a close relationship between measurements standards and engineering standards. If there exists a good set of specifications which prescribe the performance of a product, and you can meet that standard, then your products can be welcome in any marketplace. It is only necessary

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that you and your customers have confidence that your quality control procedures do in fact satisfy those specifications. So it is not sufficient that you have accurate instruments. It is not sufficient to have a good standards laboratory. What is necessary is that the product does what you say it does. Quality control is a means of assuring that the measurement actually made in the factory is as accurate as it is supposed to be. That is why I started this meeting with the warning that it is not at all obvious that the kind of organization which NBS provides, is the right thing for other societies and countries.

I would like to ask Mr. Lartey about another problem which I would think might be important in a less developed country, and indeed in a country as well developed as Canada. How do you handle your metrological problems when a part of your industrialization is based on foreign technology which uses the measurement capability of the originating country, while you also have some developing indigenous industries which depend upon local technological resources? I would think there might be opportunity for some innovative arrangements for quality control and metrological assurance that would draw upon the technology of the imported industries to assist the indigenous industry.

Mr. Lartey:

I agree entirely with you that we have to work back from the imported metrology.

Mr. Nigro:

I was most interested in the comments from India about the unions and their resistance to computers. I think they are concerned with the banking process and general stock inventories. They might have some justification for their fear in these fields, but you should still use the computer for some of your planning purposes, where the man and the typewriter can no longer plan for a whole city or a network of transportation. This is the aspect of computers on which I would like to see more discussions. We would really need another session where we talk about nothing but the use of the computer.

Mr. Felleke:

To remark on Dr. Branscomb's last comment, I see a problem if the imported industry comes from different countries. They have different standards, and to harmonize their production you need a national standards capability.

Adm. Maia:

I can say to Dr. Branscomb that we have several examples of foreign industries that have been established in Brazil. They help the local factories on their quality control procedures until they reach the level required. We find that in the automobile industry, in the electronic industry, and the chemical industry.

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Paper 6.1 - Effect of Local Government Policies on Transfer of Technology

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Agricultural development, use of natural resources, industrial growth and exports are the major objectives of all developing countries. To accomplish these objectives in a relatively short time, the countries must rely on technology input from outside sources, until such time as the nationals gain industrial experience, and the local industries, universities and governmental institutions can support research programs.

In this paper, we will discuss only technology input through private industry. Such input comes about either by licensing or by foreign company participation and management.

Licensing

Licensing implies outright purchase of technology, and normally includes process details, equipment description, operating manuals, training of national technicians and startup assistance. It may also include the checking of detailed engineering drawings and assembly, depending on the contractural terms. Payment can be in the form of a fixed licensing fee and/or royalties. Generally, licensing presents no major problems in the transfer of technology to the more industrialized nations--certain European countries, United States, Japan--because of the availability of well trained and experienced personnel. In the less developed countries, however, licensing must be done with care. Although a process seems simple in terms of process details and flowsheet, it may require several years of operating experience before the plant and process are thoroughly understood. I know of several costly cases where plants were operated improperly and inefficiently because of lack of experience and know-how. Results of this are lost sales; and usually additional investment to replace equipment, to redesign, and even to rebuild.

Foreign Company Participation and Management

The trend today is toward formation of a national company in which a foreign industrial manufacturer participates with local government corporations and/or local private interests. The foreign partner brings the technology to the party and is actively involved in the detailed engineering, equipment selection, construction, training, startup and operation of the plant, and even in marketing. One of the major contributions of the foreign partner is the training of personnel. The importance of training cannot be stressed enough. Not only in reference to technical people, but in the training of workers--equipment operators, process operators, mechanics, welders, electricians, instrumentmen, etc. At the worker level is where the real technology transfer takes place.

Foreign participation may offer the advantage of marketing for export. Usually, the foreign interest is an international company, already knowledgable and participating in foreign markets. Foreign participation helps insure that the new installation will be built, that the plant will remain in operation, and that it will be operated efficiently. This is not only important to the success of the new company, but will also benefit the host country if the product is to be produced at lowest cost and if there is a possibility to compete in export markets.

What Constitutes a Good Project?

Any new venture involving foreign participation must be of benefit to the host country and to the supplier company. It should include:

1. A positive net balance to the host country, when it considers substitution (or reduction in total value) of imports, generation of exports, equipment imports, profit and royalty remittances, taxation, duty income, etc.

2. New employment opportunities.

3. Technical training of personnel at all levels.

4. Consumption of locally manufactured equipment and parts (provided equipment meets requirements), raw materials and services.

5. Reasonable return to the company.

6. Lower local consumer prices.

7. High product quality.

The project is ideal if the product can be competitive in cost and quality for export markets. However, this is often difficult because of inadequacy of scale. In the Latin American area for example, the competitive cost is very difficult to meet in highly technical, low labor intensive industries, such as the petrochemicals, because of small plant volumes and high raw material costs. Exports of this type of product can normally only succeed through agreements between two countries on common product, with tariff protection against third countries.

Governmental Policies and the Effects on Technology Transfer

The following comments are not meant to be critical per se, but rather to point out some of the problems associated with developing industrial projects. Hopefully, they will lead to some objective actions both by foreign investors and by local governments with the aim of improving the transfer of technology.

Some of the limitations that may be placed on a foreign company participating in a new project concern (a) amount of foreign ownership, (b) payment or equity position for technology, (c) royalties, (d) dividend remittances, (e) repatriation of capital, and (f) management control. These items are vital to all parties concerned and must be resolved fairly to have a good project. However, in most developing countries, there is a trend to increase these limitations. This, plus the time and expense incurred to negotiate with the various governmental agencies involved before a project is finally approved, are discouraging new investments. In Peru, Bolivia and Chile, where there are strong nationalistic movements, it has become a "wait and see what develops" situation. Foreign companies cannot risk losing vital technology and investments in this type of environment.

Some Experiences

1. In one country we spent one year putting a project together with the government development corporation and its subsidiary, the national petrochemical company. Each was part owner, along with some other national interests. We were to be 50% owner. The project was a good one--improved

foreign exchange, prices lower than imported material, highly technical process, new job opportunities, trained personnel at all levels, reasonable profits, and a new use of local raw material. Our company management approved the appropriation for our share of the investment. Process engineering design and equipment description were started, and our research division started investigations of process changes and raw material qualities to adapt the process to local conditions. The signing of agreements and company by-laws was delayed another eight months until the conditions of dividend and royalty remittances and repatriation of capital were defined. (Royalty remittances are still not known.) During this period, the government requested that the plant size be increased 50% for export business, and they also notified us that the plant location would have to be in a promotional area to realize lower duties on imported equipment. All of this was done, yet there is still no assurance of the export business. It took fifteen months to obtain final approvals from local city, provincial, and federal government agencies to purchase the selected plant site. This site had already been declared industrial land and the owner was ready to sell when first contacted. The general manager, supplied by us and approved by all board members, was moved to the country. His efforts have been directed toward approvals required for company formation, detailed engineering, approvals of land purchase, land preparation, and ordering structural steel.

Total time lapse on this project--three years to date; two years since our management approved. We have invested considerable money in process design, research, and equipment selection. The new company now exists and local detailed engineering and construction work was under way. A new government has been elected, and the new policies adopted toward foreign investment have forced us to stop all expenditures. There have been political changes in the top management of our government partners, and we have discussed the future of the project with them. We have not abandoned the project, but we must "wait and see" what policies will be forthcoming which assure us of a safe investment.

I must say that the length of time taken to develop this project was partly our own fault. We were novices, but we feel we have learned a great deal from the negotiations with the governmental agencies.

2. In another country, a group of businessmen received a government permit to develop a project. The product is presently imported, and we supply the major portion of the market through a local sales office. We were approached by this group offering us a minor equity position for technology. This offer was made to several foreign producers. By decree, the governmental industrial development corporation is also to be a partner in this project and one of the major objectives is to export the product. The offer per se was unattractive to us as well as to the other major foreign producers. The risk is too great to take a small minority position (with no management control) involving a process which requires considerable experience and technical know-how to produce and market a high quality product. We studied the manufacturing and marketing (including exports) and made a proposal to the development institute. Just before the proposal was submitted, the business group and the development institute formed a 50/50 company to continue developing the project and to participate equally in the company. They will each exchange a small part of their shares to the supplier of technology. Also, they are insistent on locating the plant in a province which is far from the market (the business group is from this province and its members are politically strong). We will probably not negotiate this project any further for the following reasons:

(1) Location will result in higher construction costs, freight and market price disadvantages. Higher price may cause users to change to other material.

(2) Offer of low equity position is too small for the risk and expense of transferring this technology.

(3) They will not give the foreign interest satisfactory management controls on manufacturing or marketing, which we consider necessary for a successful operation--at least for the first years until nationals are adequately trained.

The local company is now planning to use technology of a small non-international producer. The quality of his major product is inferior to the present imported product. What will be the reception in the local market as to price and quality? What will be the company's export possibilities? What will be the success of this new company? We feel that the project as it now stands is not a good one; and if it proceeds will be unlikely to be successful.

3. In a third country, we started looking at a project three years ago. A proposal for a 50/50 partnership with the government was submitted to the development corporation after market and feasibility studies were completed. Negotiations proceeded satisfactorily until approvals from two other government agencies were needed for import licenses and for foreign investment. We ran into some disagreements on the project bases from these agencies. Requested changes were negotiated to a satisfactory conclusion; but at about the time approvals were to be granted, departmental directors were changed. There have been a total of five changes in departmental directors since we started negotiations. Three of these occurred after recent elections. We still feel confident this project will go. At least we hope so, because we feel it is a good project and of benefit to all interests.

We must face the fact that the trend is toward increased nationalism (in many cases a form of socialism), and that foreign companies will have to include local partners, either private or governmental, in future projects. In two of the aforementioned examples, we feel that the results of the negotiations on agreements and company by-laws were fair to all parties. Our only real problem was the delays involved in obtaining approvals. This was also a problem to the development corporations because they were just as anxious to have the projects moving along to get the plants built and into operation. However, the governmental partnership approach with foreign interests is relatively new, and it will take some planning, reorganization, and reassignment of responsibilities to clean out the bureaucracy which has developed.

Some Suggestions for Improving Technology Transfer and Industrial Growth

1. Clearly defined governmental procedures for negotiating and developing projects. Each country should publish the procedures and priorities of approvals necessary to obtain an approved project and the establishment of a new company.

2. The development corporation be the governmental negotiating agent and have the responsibility of guiding the project through the agencies involved (planning, foreign commerce, and any other approval agencies).

3. A broader use of open bids in developing projects. Limited time span for performance by the selected company without endless extensions.

4. Recognition of and mechanism for a reasonable payment for the technology; possibly establishment of a reputable committee to place a value on the technology.

5. Recognition of the benefits to all parties in having the foreign company provide the management for some mutually agreeable time for the purpose of detailed training of the nationals. I want to re-emphasize that the key issue is management of the technology. In many cases, this makes the difference in whether or not a project is successful.

6. Maintain an open mind to plant locations, considering economics and market aspects.

7. Foreign companies should consider projects which are better balanced as to mutual benefits.

8. Foreign companies must be realistic in assigning values on the technology.

9. Personnel who represent the foreign companies should be of the highest caliber, sensitive to the country and the people.

10. Foreign companies should be of assistance in locating debt capital when necessary.

In summary, the development of a new project should be a joint effort with all partners contributing!

Future

Looking into the 1970's, we can see the following trends:

1. Increased pressures and policies to nationalize industry. Foreign companies in new ventures will be forced to participate with local government corporations and/or local private and public interests. There will also be increased pressures on the foreign company to accept a lower equity position and less managerial control.

2. Closer scrutiny of payment or equity position for technology and know-how, royalty fees, remittances of profits and royalties, repatriation of capital, price controls, reduced foreign participation capital, or complete nationalization after specified years of operation.

These trends are forcing foreign companies to think twice before investing in a developing country. Somewhere, somehow, there has to be developed a system for balancing all of these considerations so that the country realizes its development goals, and the foreign investor is justly compensated for the transfer of technology.

Discussion on Paper 6.1 - Effect of Local Government Policies on Transfer of Technology

Co-chairmen: Zawdu Felleke and Newman A. Hall

Dr. Sabato:

First of all, I would like to congratulate Mr. Pratt on his most realistic paper. It has a number of interesting features. Some of them, however, seem to me to be somewhat biased about situations in what I suppose was Latin America. Perhaps the author forgets that he accepts a situation in the USA but is not willing to accept similar situations in Latin America. For example, the change of mind on the part of government. Recalling the case of the supersonic transport, I would like to listen to a speech by an officer of the Boeing Corporation about the SST and how unstable is the government of the USA. Another example is the well-known plane, the C-5, built by the Lockheed Corporation. Lockheed seems to have so many difficulties with the Pentagon about who is going to pay the bill for that fantastic plane, that really when I read in the newspaper about the discussion between them, I sometimes think that the Pentagon is the Pentagon of a Latin American state instead of being of the USA. Perhaps three years is a lot of time for a discussion of one project, but three years is nothing in the history of the C-5 project.

The author made some comments about location. He is critical because the government institution in charge of development discovered one day that some other province was the best place to put the project. I remind you that, when Senator Kerr was chairman of one of the committees in the Senate, one of the big rocket centers was put in Oklahoma on land that by coincidence belonged to him.

Mr. Pratt makes some comments about technology transfer that I consider very proper. Dr. Ghosh today used a phrase that I consider very important. "Technology know-how is a commodity of commerce." Transfer is really a misleading word. What we are talking about is technology commerce. This is more than a semantic point, it is a realistic point, because "transfer" seems to have a philosophical implication, something like good will. However, you are going to sell; we are going to buy. If Mr. Pratt would just say "technology commerce" I would absolutely agree with him, and I will say that with technology commerce you can really arrive at better deals than the deals you get today.

A final point that I think is also important to emphasize is that personnel of the highest caliber should be guaranteed in this kind of transaction. Many companies have been using second or third-rate personnel. My own country, Argentina, dealt with two big American companies, one of which was subject to much pressure from nationalists, and another which was free from this sort of pressure. Once I was asked by the manager of the first company why his company was so much under pressure. My answer was very simple, If you compare the management of your company with the management of the other company, you will have the answer.

Dr. Tabor:

I cannot speak for all of the developing countries and what I say does not necessarily apply to Israel, but one of the things that I have noticed about foreign firms operating in less developed countries is that they keep for themselves the sales networks in the outside world. I agree with

Mr. Pratt that the foreign company should have control of the management of the new enterprise if this is for technical purposes. I can well understand the reluctance on the part of the recipient government to agree to control, particularly when the sale of the product is in the hands of the parent company. One of the reasons why new industries in less developed countries often do not succeed is because we do not have good marketing facilities. When a company sets up a new plant in a developing country and maintains for itself the sales of the product in the outside world, there is always the suspicion that most of the profitability is in the selling process, not in the manufacturing process, and I think this is the reason why the governments in question insist that they should have a strong share in management. The foreign company must understand this in the negotiating stage. I agree that from the purely technological point of view it is desirable that the foreign company should have the management.

Dr. Cushen:

If I hear Dr. Sabato correctly he says, I do not know what you mean by technology transfer; what I wish to buy is technology as though it were goods or a service. Can you tell me what you mean by a package you would call technology that you would be willing to buy?

Dr. Sabato:

What I tried to emphasize was that when a company goes to a country, say to invest capital or to advise a local firm, there is something like goods in the transaction called technology or know-how. Sometimes it is called good-will. It depends on the tradition of the company, or on the way this transaction is made. You have a real commodity of commerce being transacted between the two partners. You buy and he sells.

Dr. Cushen:

Can you separate the part of the package that is called technology from the rest of the thing that you are buying?

Dr. Sabato:

Due to the fact that the underdeveloped countries are ignorant, not always is a good separation made. I will give you two examples for you to understand what I mean. My first example is this: you buy a pharmaceutical recipe, and you pay for example 3% of the net sales as a royalty. You suppose that all you are paying is 3%, but then the contract says that you must buy some of the constituents of such products from the foreign company, which may be in America, Germany, France, or England. You are paying not only the visible 3%, but you are paying a lot more for constituents. In your ignorance, you take all the package together, and this is called nowadays the iceberg effect. The 3% is the part you see, but there may be another 40% you do not see.

Dr. Cushen:

Why don't you raise the price and say all I want to buy is the tip of the iceberg?

Dr. Sabato:

Because we are ignorant. This is why, and this is the definition of underdevelopment.

Dr. Cushen:

I was operating under the impression that we were not talking about ignorance but rather about inability to pay.

Dr. Sabato:

No, we pay completely. That is a true example, which I am not inventing. Another example which has been published has now been penalized by law in Colombia. Colombia conducted some very interesting research in two industries, electronics and pharmaceutical products. Still there was an iceberg effect which was discovered and proved, unfortunately only after a contract had been signed.

Suppose instead of using the phrase "transfer of technology" we used the phrase "technology commerce." This would clarify things because you will not be under the impression that you are getting something for nothing. You never get something for nothing. You always pay for it. Unfortunately, transfer of technology has the wrong connotation, I would say, a romantic connotation. It is in a way connected with the scientist who is creating the knowledge that is creating the know-how that is creating the product, but when you go into selling and buying things the scientist has disappeared.

Dr. Cushen:

How about if we created a separate cost center inside of a corporation, and call it capital investment in technology. You capitalize your R & D and then you sell the R & D service which goes back to restore this capital. Would you be willing to buy from the account that is labeled technology, provided a fair price were established for that?

Dr. Sabato:

Surely; this is what is happening now. I am willing to buy ideas, and operators, and manuals--all of the package, but the important thing is to know what is in the package. In the case of Colombia and now in the case of Argentina, the law requires that everything must be identified--how much know-how, how much personnel, how much R & D, how much good will, how much advertising, and how much public relations.

Mr. Birch:

I would just like to mention that the United Nations Trade and Development Board at its recent meeting in Geneva fought very hard over a resolution to set up some institutional form for technology transfer. The result was to set up a group of experts who are going to try to thrash out this whole problem.

Mr. Daneman:

Dr. Sabato made an impassioned rebuttal to the paper by Mr. Pratt which I read in the author's unexpected absence through illness. I feel compelled to make a very short defense. First, Leeds and Northrup (the speaker's employing company) has five foreign partnerships. Workers in these plants are nationals of their countries. The technical people are nationals of these countries and the managers are nationals of these countries. We do not export people from the USA to these plants. On the other hand, the manager of one of these foreign plants became our vice-president of international operations.

With regard to management control, we make a contract with our partners and have every reason to believe they live up to the contract, which specifies the quality control that we require if the product has our name on it. It specifies that the components should be interchangeable, but locally procured wherever possible. It also specifies that the performance claims on these products be neither enhanced nor diminished from the original product.

There is some research done locally, for products which are not only for local markets but for export and not necessarily to the USA. We do not ask for these products, and we make no commitment that we will buy them. When a production run is completed, the product is evaluated. If our domestic marketing division thinks it will sell here, they buy it.

Finally, I offer a comment with regard to licensing--lump sum arrangement versus royalties. At the time such a company starts up, lump sum payment is difficult. There are better uses for the capital. It seems better that the payment be a fraction of whatever sales result when sales do come about. However, unless a new design replaces the older designs, the royalty payment diminishes within a reasonable interval.

Dr. Sabato:

You mentioned the intermediate solution that you receive a royalty only for a certain period, so perhaps after five years you would receive none. This is a good compromise, and let us hope that within that time you have your return a few times over. Governments of recipient countries are being very careful because some bought technology 20 years ago for which they have been continuously paying until now. One example was the manufacture of tennis balls, which has been going on now for 30 or 40 years and the agreement says the royalty will be on sales.

Mr. Felleke:

It is really a necessity to transfer technology, but we can also invent technologies adapted to our particular economic needs and physical requirements. The national standards institute should be geared to the proper allocation of national resources.

Dr. Rohatgi:

Some seemingly recriminating dialogue has gone into the record on the sale of technology transfer between private enterprises. This kind of dialogue would fit better were there more representatives from private companies. Apparently most of the people here are from aid-giving institutions which are good-will oriented. We in the less developed countries do appreciate the help we receive on the basis of good-will. I am trying to soften the dialogue. So I want to make a distinction. There is a lot of good-will to benefit our technological development; we do appreciate it; not all of it is commercial. I hope my colleagues will agree.

Dr. Sabato:

I do not agree because it is a semantic misunderstanding. Good-will is part of the transaction, and you pay for it when you sign a contract for a license.

Mr. Daneman (responding to comments about the quality of the technology after transfer):

Our company, as some of you know, manufactures recorders and we think we know all about them. However, two of our foreign partners in different countries had the audacity to get together to design what they thought was a better recorder than we had ever built. They did it, we buy it, and it is good. Without question, they had the technology to do it.

Paper 6.2 - The Sale of Instrument Manufacturing Technology to Small Private Industries in Developing Economies

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The trade in technology between different countries presents many additional problems as compared to the trade in technology within a country. Mr. G. E. Pratt has identified some of the problems encountered in the sale of large-scale technology to developing countries, including government intervention, undue delays, questions about managerial control and repatriation of profits. I wish to discuss the sale of small-scale technology to small-scale private enterprises in industrializing economies. My remarks will be based on India as an example of an industrializing economy, and the manufacture of instruments and scientific apparatus as a possible technology to be traded. To illustrate a few points, I have included a case study based on my personal experience.

1. Some Opportunities for Easier Technology Trade

The small-scale private industries in developing economies are attractive customers for technology sale because the bureaucracy within them is smaller than with the large private customers or the governments. The responsibility of obtaining government approval can be totally left to the customers, who know their way through their respective governments. The most attractive form of payment for the technology sale is in the form of a lump-sum licensing fee or a short-term royalty payment. This eliminates both the problems of managerial control and the need for policing the fairness of customers in paying long term royalties. In fact, governments in industrializing economies generally do not permit arrangements involving indefinite-term royalty payments, especially if they are to be made in hard currencies. The know-how for labor-intensive industries finds a market far more easily in industrializing economies as compared to capital-intensive industries. The industrializing economies then have a chance to export the products of their labor-intensive industries to developed economies where the labor costs are higher; the government approval for such industries also are given more easily since they promise more employment opportunities. In fact the vendors of technology in developed countries should look for customers who are already exporting products to developed countries, since these customers can pay fees or royalties in hard currencies. I will now specifically discuss small scale private industries in India as potential customers of instruments and scientific apparatus manufacturing technology.

2. Potential Market for Instrumentation and Scientific Apparatus Technology in India

In India the government is encouraging small-scale industries--those which by definition have a capital investment of less than $100,000 in plant and machinery. The government has reserved certain items to be exclusively produced by the small industries to protect them from competition by larger industries. Statistics collected for the year 1968 showed that small-scale industries constituted close to ninety percent of all the

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*Formerly Visiting Faculty Member, Indian Institute of Technology, Kanpur, India production units in India, and they produced goods worth more than $3200 million dollars per year. The small-scale industries produced both consumer items and industrial components for larger industries. These small-scale industries represent a very attractive market for the sale of technology from the industrialized countries even though the revenues involved in individual transactions are likely to be small. Recently the Development Commissioner for small industries in India identified opportunities for several industries which had good prospects. Some of the items identified were: (a) optical and scientific instruments including telescopes, binoculars, microscopes, projectors, spectroscopic instruments, surveying instruments, cameras, medical instruments such as X-ray diascopes, length measuring machines, optimeters, polarimeters; (b) electrical measuring instruments including flux meters, resistance bridges, power factor meters, impedance bridges, vacuum tube voltmeters, oscilloscopes, sound level meters and attenuators. This list indicates that the manufacture of scientific apparatus and measuring instruments will be done primarily by small-scale industries in India, and therefore the technology vendors in these areas should concentrate their attention on small entrepreneurs. Moreover, the Ministry of Industrial Development and Internal Trade in India has identified several areas in which it will permit investors to seek foreign collaboration; the list includes scientific instruments and precision measuring tools. This implies that the purchase of foreign technology in these areas will be approved without undue delays.

3. A Case Study in the Sale of Technology to Industrializing Countries

In this example I will present some of the difficulties encountered, and some of the solutions found, in the transfer of technology from a small private industry in the United States to a small private company in India. Such difficulties are likely to be encountered in any technology transfer transaction between two countries. I hope the representatives of American private industries and the delegates from the developing countries present at this seminar will work toward eliminating such obstacles so that more technology transfer can take place.

The particular case I will discuss involved making precision castings by a ceramic molding process. Precision castings are very attractive for developing countries, since they reduce the use of complex machining equipment and the loss of material as a result of machining. Moreover, precision casting is a labor-intensive process since it cannot be automated easily. A small American company had developed proprietary know-how on the particular type of ceramic powder and the liquid chemicals which were most suited for making molds for making precision castings. This American company was already licensing its process to manufacturers in the United States, Europe, and Japan. The company also offers to sell the chemicals and the ceramic powder to its licensees. The company had received some inquiries from Indian companies who had come to know about the process through technical papers in international journals. The company was therefore interested in potential markets in India and other Southeast Asian countries.

Acting as a technical representative of this American company during my trip to India, I presented a technical paper on the process at the annual meeting of the Indian Institute of Foundrymen. In addition to the details of the process I described the availability of the know-how for Indian customers and the potential markets for the products in India. The oral presentation generated a great deal of interest and many questions followed from the audience. Most of the questions dealt with the conditions of licensing, availability of raw materials in India, mechanism of transferring the know-how and the technical merits of the process. As a follow-up, the written version of the paper was published in the Journal of the Institute of Indian Foundrymen with an appendix containing the questions raised and the answers given. The American company then received inquiries from about thirty potential Indian customers who were seriously interested in buying the technology. These serious customers were now asking questions about licensing fees for the process and its technical viability in producing the specific products they wanted to manufacture for Indian markets. The two messages of the story up to this point are: (a) traveling scientists can be used as an instrument of technology sale between small private industries at relatively little cost to the parties selling or buying the technology, and (b) oral and written presentation in the professional societies in developing countries is a very effective means of advertising technology for sale in that country.

Now let me come to the problems encountered in technology transfer, despite having an interested vendor and interested customers in two different countries:

1. The American company wanted the licensing fees in dollars and the Indian company could not give the fees in dollars without the government of India approving the collaboration and granting the foreign exchange. The government of India took about a year and finally approved the scheme with the condition that the licensing fees be paid in a lump sum, instead of as a royalty continuing as a certain fraction of profits or sales indefinitely. The lessons are: (a) the American vendors should think of means of getting the price of their know-how in currencies other than dollars and preferably ask for a lump-sum price, (b) the developing countries should reduce the time they take in examining a collaboration proposal, and (c) the American companies must understand that obtaining government approval for foreign collaboration in developing countries takes at least a few months.

2. The Indian customers were worried about the continuous availability of the ceramic powder and liquid chemical needed to make the molds within India, since importing materials from the United States would not be allowed by the government of India due to balance-of-payment problems with dollars. In this case we were able to identify a manufacturer of refractories in India who agreed to supply the ceramic powder to the specifications of the American company. The problem of importing the liquid chemical still remained; the chemical cannot be economically manufactured in India on the small scale required for the ceramic mold industry at this time. This problem is being solved by arranging the import of the chemical from Japan. Importing from Japan is easier since India exports to Japan a large quantity of raw materials, including iron ore. Furthermore, in order to reduce the amount of yen needed as foreign exchange to buy the liquid chemical, we are in the process of arranging the export of the ceramic powder from India to Japan. As I mentioned earlier, the American company had licensees in Japan who were importing the ceramic powder from the United States while using the process. To buy the ceramic powder from India will be cheaper due to lower labor costs, than it is from the United States. Thus, the yen needed to buy the liquid chemical will be obtained by exporting ceramic powder from India to Japan. The messages here are: (a) the American company should thoroughly investigate and arrange beforehand the availability of the required raw materials and supporting infrastructure in the developing country before advertising the process, and (b) the American company should look for ingenious means of getting labor or raw material exported out of the developing countries in return for the know-how or the goods that have to be imported. A country like India with cheap labor can be used as a manufacturing site for American goods to be exported to other countries including Japan, Australia, and Southeast Asia.

4. Conclusions

1. Small scale private industries in developing economies are a large group of potential customers of small scale technology with prospects of easy trade. Technologies that are labor-intensive and have been approved

for foreign collaboration in the developing economies find markets relatively easily; instrument-manufacturing technology fits this criterion in the case of India.

2. The vendors should try to get the price of their technology in lump-sum licensing fees or limited term royalties preferably in softer currencies. The most attractive situation is where the vendors can accept labor and raw materials from developing countries in return for the technology.

3. The use of traveling scientists, who expose the technology through talks or written papers in local trade or professional societies in developing economies, is a very effective and inexpensive means of advertising the technology available for sale.

4. The technology vendors should ensure the availability of infrastructure and the necessary materials for the operation of the technology in a developing economy before advertising it for sale.

Paper 6.3 - The Iranian Institute of Standards and Industrial Research

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A few months ago I came back from Iran after two years there and was asked by your Program Committee to discuss the work of the Institute of Standards and Industrial Research, ISRI. In the UN lineup I was listed as advisor in industrial research; the standards advisor was Dr. Sen from India. Dr. Ghosh has persuaded him to go back to India and become his successor at the Indian Standards Institute, and I want to say that India has contributed a great deal to the standardization work of Iran.

There was one question we discussed yesterday--whether you start your industrial program from the scientific end or from the industrial end. In Iran they did the latter. ISRI in 1960 had seven engineers; now the total number of employees is somewhere between 800 and 1000.

It may help to have a few comments on the parameters of the country, because in discussing these matters I think there are two vital items. One, how big is the country and how much research can it stand? For instance in Luxembourg they find they cannot have a big research program; they have to import all their technology. The population of Iran is 30 million and it is increasing by 3% per year, which is quite high. The area is 1,000,783 square kilometers. The gross national product is running at about seven billion dollars. The annual growth rate has been running 9% or more for the past eight years, and that has been corrected for inflation which has been running between 1 and 1½%. This is a pretty good record, and emphasizes my belief that developing nations must relate their programs to their needs and resources, not blindly pattern themselves on the industrial giants of the world. A description of ISRI is given in the last issue of Quality Progress published by the American Society for Quality Control.

In the first stages of development, it is necessary to imitate older technologies--call the process adaptive research, since you do have to modify slightly what is brought in. In subsequent stages, there are seven items which I consider essential elements of the anatomy of an industrializing economy:

1. An enlightened, strong and interested government.

2. Investment capital.

3. Industry complete with technology.

4. A society adaptable to change, which can produce the necessary industrial skills.

5. Competent planning.

6. Entrepreneurs.

7. An education program.

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These are all vital organs of the anatomy. Their significance and importance will shift with the industrialization of the economy. For example, at the beginning government should have a strong and beneficent effect to set the pattern and hold all elements accountable for their performance. It will be the principal force determining whether the program will produce a viable industry, or merely a series of status symbols. Investment capital will be essential, even though a developing economy favors labor intensive rather than capital intensive technology. Industry complete with technology is so expressed to reinforce the idea that in this relationship science and technology are dependent on industry. The importance of a receptive society cannot be over-emphasized. Programs can fail because of the people. Competent planning is always necessary to an effective industrialization, as are the entrepreneurs to make that program move. Finally, there must be education, for the critical ingredient is personnel. This presents special difficulties. It takes about forty years, from graduation to retirement, to produce the cadre of scientists, engineers, and technologists who staff the industries. Assuming that these people are being trained as rapidly as possible only about 2.5% per year can be expected to have the abilities and inclination to be channeled into these fields. There must be inducements to bring them directly into industry, and to defer activities which do not make a prompt contribution to the economy. Where the shortage is acute, employees, advisers and consultants must be imported with the technology.

Industrializing economies would do well to transfer to themselves the technology of the already industrialized countries. This is based on the premise that it is quicker and cheaper to obtain it in this way than to develop it locally.

In preparation for a UNIDO assignment in Iran, I collected publications about that country from the U.S. State Department and the Department of Commerce. These bulletins were useful and informative. Yet, nowhere in the 58 pages of close print do I recall the words science, technology, engineering, standardization, or quality control. The subject matter concerned mainly economic values and legal arrangements. The technical aspects were, I assume, taken for granted as part of the total package. Here are a few examples of how technology can be transferred to fit a particular situation:

The oil industry of Iran is operated by a consortium of Western oil companies under contract. Practically all the technology is currently imported, although the National Iranian Oil Company does operate a small but promising research laboratory.

The automobile industry is somewhat different. Several makes of cars are assembled in Iran. One of these, the Hillman Hunter, is produced by the Iran National Company, which is Iranian owned. It is called the Paikan car. In this instance there is ample evidence that the technology is being made available to Iran. The question is how long it will take to assimilate it.

A third instance involves modernizing and introducing new technology to an already existing industry. Natural dyes such as madder, tea, walnut, etc. have been traditionally used in making Persian carpets for hundreds of years. It is claimed that they are superior in durability to modern synthetic dyes, but lack variety and are not uniform. To study the natural dyes, an Iranian engineer, with experience in the USA, was assigned to the project. He began applying the extraction, distillation, fermentation, and separation techniques of the pharmaceutical industry to produce successfully new colors and shades of colors unobtainable in the past.

NBS SPECIAL PUBLICATION 359 - Metrology and Standardization in Less-Developed Countries: The Role of a National Capability for Industrializing Economies.
Proceedings of a Seminar, 1971.

Paper 6.4 - Institutes for Engineering Education as a Source of Metrology, Standardization and Quality Control in Industrializing Economies

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1. Introduction

Institutes for Engineering Education can be an important source of standardization and metrology in industrializing economies. Often they have the best technologically trained minds with the best equipment at their disposal in the regions where they are located. These institutes can therefore play a very significant role in catalyzing industrial activity, in addition to teaching and research. This paper will be based primarily on the experiences at the Indian Institute of Technology at Kanpur, India. The discussion of this particular institute has special relevance to this Seminar because the major portion of the funds for its establishment were provided by the USA Agency for International Development, and the NBS sponsors a considerable amount of research there. IIT, Kanpur represents a teaching institution comparable to the best in the world, located in one of the poorest states of India (Uttar Pradesh).

Presently the Indian Institute of Technology, Kanpur, has approximately 1400 undergraduates, 500 graduate students, and a faculty of 250. It offers bachelors degrees in aeronautical, chemical, civil, electrical, mechanical, and metallurgical engineering. The graduate degrees include physics, chemistry, mathematics, humanities and social sciences in addition to all the above fields of engineering. The USAID funds for IIT are administered by an Educational Development Corporation. The American assistance has matured into the Kanpur Indo-American Program (KIAP), a consortium of nine U.S. Institutions--California Institute of Technology, Carnegie Mellon University, Case Western Reserve University, Massachusetts Institute of Technology, Ohio State University, Princeton University, Purdue University, University of California at Berkeley, and University of Michigan. Several American faculty members from these institutions have been at IIT on a visiting basis to assist in its development. In this sense the IIT represents a case of technology software transfer which is one of the topics of this Seminar.

2. Standardization and Metrology in India

Currently in India, it is the Indian Standards Institution in New Delhi which lays down the standard specifications for industrial goods and the codes for industrial practices. Dr. A. N. Ghosh discusses the Indian Standards Institution (ISI) in his paper. The specifications for some of the small scale industry products not covered by the ISI are drawn up by local bodies, such as the Director of Industries for that particular state or the Small Scale Industries Service Institute. For instance, in the state of Uttar Pradesh a Quality Mark scheme has been pioneered, under which the products meeting certain specifications are stamped with the symbol "Q" to certify the product. There are inspection stations set up

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across the state to police the proper use of the symbol "Q". Metrology standards in India are maintained by the National Physical Laboratory in New Delhi. Despite these efforts by the governmental bodies in metrology and standardization, the state of quality control in India remains far from satisfactory, and it is reflected in the relatively poor performance of the manufactured products. As we have heard from other delegates, this appears to be a common problem in most industrializing economies.

Some of the reasons for the unsatisfactory quality of goods manufactured in India are:

i) a sellers' market and lack of competition,

ii) lack of proper equipment and trained personnel for measurement and quality control,

iii) lack of funds and equipment to enforce the standard specifications prescribed by the government bodies, and

iv) lack of quality consciousness amongst the masses of the people.

The last obstacle is probably going to be the most formidable one in the long run; the agrarian population in the process of changing into a technological society has difficulty in comprehending the complex and rigid requirements of industrial components. The fact that a single substandard component like a nut or a bolt can bring down vast structures, and can trigger a chain of events undesirably affecting the lives of a great many people, has to be impressed on individual minds. Cultivation of an industrial attitude including respect for specifications, precision, and quality is not an easy task in a population more than half of which is illiterate. Quality control requires the methods and the will, in addition to the availability of hardware for metrology and standardization.

The production of equipment for controlling the quality of the various goods is also far from sufficient in India because of the need for the very special technology required in their manufacture. In view of this the government has decided to permit foreign collaboration for the instrument industry. Private industry does not readily undertake the manufacture of these items since their markets are not as large as for some of the consumer items. In the state of Uttar Pradesh the state government has set up a factory to manufacture instruments. The central government has also set up a Central Scientific Instruments Corporation to look into the production of instruments. In India a large percentage of goods are produced by small-scale industries who cannot afford their own testing equipment and cannot produce standardized products unless some services are available. For instance there were small foundries in the Kanpur area which could not afford their own chemical analysis laboratory, microscopes, and mechanical testing equipment. They needed the services of the IIT to perform these tests and obtain necessary certification.

3. Interaction Between the Institute and the Industries

The IIT at Kanpur has taken the following steps to participate directly in the industrialization of India, in addition to the most important role of training technical manpower:

(i) IIT arranges summer jobs for the faculty with the various industries in India. This brings the faculty in touch with the industrial problems specific to the Indian scene, and the industry obtains a feel for the services of a highly qualified person without a large investment. In a few instances the faculty members were permanently hired by the industries after the summer employment. Very often the faculty continued to work on the same problem at the Institute even after returning there.

(ii) The students are required to spend a minimum of ten weeks with an industry as a trainee as a part of the undergraduate curriculum. IIT has taken the lead to convert the unpaid traineeships into paid summer employments for some students. The latter results in improved benefits for both the students and the industry due to a definite commitment. It is hoped that the students will bring back industrial problems for their thesis work as a result of summer employment and that some of them will be hired permanently after graduation.

(iii) IIT arranges several conferences and short courses on industrial subjects each year, which brings the industrialists to the Institute. This gives them a chance to discuss their problems with the academic community and obtain a first-hand look at the facilities of the Institute.

(iv) IIT has started a Student Placement Office which arranges campus interviews and plays host to the visiting industrialists. The Placement Office in 1968 arranged a seminar on "How to Start Your Own Industries" to promote self employment amongst the students through entrepreneurship (copies of the proceedings of this seminar can be obtained from H. S. Peiser, National Bureau of Standards, Washington, D. C. 20234). The proceedings contain case studies of Indian engineering graduates who have started their own industries, information on the help available from Indian government to engineers for starting their own industries, and some opportunities for starting new industries. The object of the proceedings is to stimulate the students into starting their own production units after graduation instead of looking for jobs elsewhere or taking up research. Presently in India there is a surplus of engineering graduates and it is difficult to find a job.

(v) IIT undertakes applied research which is of potential use to industry; some of this research is sponsored by industry and the rest is funded by government agencies.

(vi) IIT encourages the faculty to consult with the industries and to make use of the equipment and the services of the Institute, after making suitable arrangements with the research administration.

(vii) The computer center of IIT provides service work to local industries and other institutions in the area.

I would now like to point out some of the difficulties faced by an Institute like IIT in interacting with industries in less developed economies. In the USA and Western Europe the educational institutions have evolved over a long period of two centuries in accordance with the needs of industrializing society, and therefore have a better chance of being relevant to their surroundings; but even then we hear questions about their relevance to society. In newly industrializing countries most of the institutes for engineering education have been set up recently. They emulate the curricula of the best institutes in the industrialized countries and, therefore, a relevance gap is inevitable. Furthermore, it is an unfortunate paradox that, the less technically competent an industry is, the less it interacts with educational institutions. This had been the case in the USA where the industry-institute interactions increased only in the last thirty years with the sophistication of industry. We, too, have found that the more advanced of the Indian industries, who already have technically qualified people, have interacted well with IIT. This implies that the task of university-industry interaction is most difficult during the initial stages of industrialization, just when it is most needed in developing economies.

There are other questions that are being asked at IIT, Kanpur, about assistance for industrialization: Can IIT, which already has to struggle very hard with its limited facilities to maintain international standards of excellence in teaching and research, afford to channel some of its energy to the solving of local problems? Should relevance be given priority over international competition in generation of scientific knowledge? Should the professor or the student who solves a local industrial problem be rewarded more than those who contribute to international scientific knowledge? What should be the distribution between basic and applied research? Despite these dilemmas IIT is interacting with Indian industry and participating in the economic development of India at an accelerating pace every day.

4. Promotion of Metrology, Standardization, and Quality Control by the Institute

We see that the institutes for engineering education in an industrializing economy can be at the crossroads of a considerable amount of industrial traffic. An institute like IIT, Kanpur, can therefore very effectively promote standardization, metrology and quality control in industrializing economies in the following ways:

(i) The institute can introduce courses in metrology, instrumentation, and quality control in its curriculum and encourage the students to take up careers in these fields after graduation.

(ii) The institute can develop a sophisticated instrumentation and measurement laboratory to provide measurement, calibration, and repair services to the local industries. The investment in extra manpower and equipment might be recovered by the income from these services. It is likely that the technicians from the institute laboratory would be hired away by the industries and the institute will thus serve as a source for technicians trained in metrology. Presently IIT, Kanpur, has an excellent instrumentation laboratory which is air-conditioned and dust-proof. It is difficult for local industries to provide this type of facility, which is necessary for the proper repair of sensitive instruments.

(iii) All the other laboratories of the institute, such as those for chemical analysis and materials characterization, could provide these services to the local industries at suitable charges. The institute will have to develop enough competence so that its certification will be recognized by the appropriate standardization authorities. The institute can hire additional technicians who can use available equipment for providing outside services when it is not in use for teaching or research. The idle time of the equipment should be reduced to a minimum in industrializing economies.

(iv) The institute could encourage the students to build from locally available materials the measuring instruments needed to maintain standardization and quality control in local industries, as a part of their project and thesis work. The know-how generated could then be turned over to local industries.

(v) The institute should encourage the faculty and the students to identify the problems in maintaining standards and controlling the quality under local labor and climatic conditions and conduct research in solving these problems. One of the areas of research could be developing quick methods of calibration with locally manufactured gadgets, as pointed out by Dr. Harry Tabor in his paper.

(vi) The institute could encourage the students to measure the properties of locally available raw materials or locally produced industrial goods as a part of their laboratory exercises.

(vii) The institute could develop inexpensive textbooks for students and technicians in local languages in the fields of metrology and standardization. The institute could arrange trips for visitors, especially high school students, through its instrumentation and metrology laboratories, coupled with movies showing the economic losses and other undesirable consequences resulting from the lack of standardization and quality control. This would help to increase the awareness among the population about standardization and quality control. An individual raised in a highly industrialized society has a very good chance of automatically developing the industrial attitude, but in industrializing societies the individuals will have to be educated into acquiring an industrial attitude.

5. Conclusion

The IIT, Kanpur, is already beginning to take some of the abovementioned steps, and similar institutes for engineering education have a great potential in promoting standardization and quality control as a catalyst in industrializing economies. The NBS and USAID can help in tapping this potential by specifically allocating their funds for standardization and quality control efforts at these institutes.

Paper 6.5 - Design and Development Through Metrology (Abstract)

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The National Physical Laboratory of India, in implementing the 1956 Standards of Weights and Measures Act, adjusted and calibrated mass standards of 50 to 10^{-6} kg for 250 State Laboratories. Most of the 5000 balances needed by Inspectors were designed and fabricated by four commercial manufacturers in India, with specifications, technician training, and performance testing supplied by NPL. With this experience, two manufacturers designed and fabricated the higher precision balances for District-level laboratories. The technique is recommended to developing countries faced with similar projects.

* From NBS SP 335, Innovative Metrology - Key to Progress.

Paper 6.6 - Nondestructive Testing

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The organizers of the Seminar have been particularly keen to avoid giving undue emphasis to the work of the NBS, so I have chosen some work which has no connection with NBS. For that I had to go back to my activities before 1957 when I came to this country. The reasons for wishing to describe such old work is that I want to make the point that the technical infrastructure in a less developed country often should be technique-oriented. You do not want to rely entirely on mission-oriented people, because there are many techniques of science which are specialized yet useful in diverse applications. To avoid each kind of industry having separate laboratories with all kinds of techniques the national capability should provide certain technique-oriented groups. They can be very small groups and they can serve for all relevant applications. However, as was pointed out in the discussion on the first session, you must not expect people in industry to come and ask to use these facilities because they cannot appreciate the potentialities. I also want to point out that sometimes several completely different techniques can be applied to solve a particular problem. The most characteristic feature of industry in the USA is that it has people who are inventive and who are able to solve their problems by using any of a number of effective techniques according to personal experience and inclination.

The technique I am going to talk about is nondestructive testing, and radiography in particular. There is not a single country I have ever visited where I could not have put up existing medical radiographic equipment to solve most industrial problems suitable for radiographic techniques.

You can use radiography to see what is inside a black box which cannot be opened. This feature is very useful for the repair of instruments. In a related type of application, you can monitor a process inside a container, such as the evaporation of liquid oxygen in a Dewar cylinder. Next you can look at the quality of a weld. I believe that no welder can possibly be trained without looking at radiographs of his welds. So you can use radiography as a very important teaching technique. We heard earlier in Dr. Kushner's remarks about corrosion type cracking, that can cause disastrous failures of engineering structures. Incipient cracks can easily be detected by a number of nondestructive techniques, and can be seen radiographically long before the piece fails. A completely different application is the development of optimum foundry techniques for large or high-duty casting. The pouring of the liquid metal, the temperature gradients, and the rate of cooling are controlled so that liquid metal is never engulfed by solidified metal. You can guide radiographically the development of the foundry technique so that there are also no voids or trapped gases in the final casting.

The use of gamma radiographic equipment is also simple using a cobalt-60 source which can be transported anywhere in a lead container. In Malaya I radiographed chains of 200 elevator buckets each weighing about 200 kg and carrying about a cubic metre of tin-bearing sludge. The pull on these buckets is about 300 tons. When they fail, the whole chain drops into the "pool", and it is a very expensive business to fish them out from 50 feet below the surface. What one wants to do is to make sure that these buckets are not going to fail. This is achieved by radiographing the known danger zone where the eye at the top of one bucket is pinned to the adjoining bucket. For the undercarriage of airplanes, the use of castings which save a great deal of machining costs would be extremely hazardous without radiographic inspection.

Turbine and compressor blades of jet engines such as those made by the lost-wax investment process of precision casting can be radiographically inspected in large numbers. Blade failures due to vibrational resonances can be avoided by assuring the presence of large crystals. They will have different natural frequencies, so the engine assembly will not be prone to pronounced resonances. Their production is readily controlled by a high voltage x-ray diffraction method using radiographic equipment.

Paper 6.7 - Problems and Attitudes in Operating and Maintaining a National Standards Laboratory in a Small Developing Country*

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1. Origin of the Standards Laboratory

The National Standards Laboratory in Israel was established first in 1950 as a part of the National Physical Laboratory of Israel (NPLI), for the purpose of:

(i) Maintaining basic physical standards,

(ii) Helping industry by giving service and precision measurements, and

(iii) Encouraging new industries in the field of precision instrumentation.

After a few years of activity, the working staff dispersed and the Standards Division stopped functioning. The Engineering Metrology Section was transferred to the Standards Institution of Israel (SII), which issues standards specifications, and tests products for conformance with these standards. The Standards Division started to function again in 1960 when the author of this paper was appointed as the Head of this Division. In 1964, the author visited National Standards Laboratories in England (NPL) and in France (Laboratoire National D'Essais). A small budget (about $10,000) and a second technician were then allowed for the Division. Since then there has been a continuous increase of activity.

2. Growth of the Standards Division

This paper attempts to explain the process of development of the Standards Division, the problems encountered, and the characteristic features of a standards division in small developing countries in general, and in Israel in particular. The first major problem which was encountered was the lack of understanding of the subject by industry. The main reasons for this were:

(i) The absence of competition faced by industry in the local market, which is a "seller's market."

(ii) The fact that industry was at an early stage of development, most of its products being simple, with no problem of interchangeability.

(iii) Industry had not reached the stages of automation or quality control.

A survey of the situation in industry was undertaken in 1962 as a

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* Paper presented for discussion at the NBS/AID Seminar, February 1-4, 1971, on "The Role of a National Capability in Metrology and Standardisation in Industrializing Economies." See also Paper 3.3

part of the background material for the visit of the late UN metrology expert, Mr. R. Cohen from France, who was asked to advise the NPLI on this subject. He found that there was an "inverted pyramid" in Israel in the sense that institutions like the University and the Technion were highly developed for research work, while industry lagged far behind in its development. He discerned some signs of quality control, and expressed his opinion that the need for precision measurements would grow. Indeed, an increasing pressure of demand was felt by the Division before the end of 1962.

The phenomenon of the "inverted pyramid" was clearly reflected in the years 1963-1965 in the proportion of precision tests demanded by scientific institutions to the total demand. That the pyramid turned right-side-up between the years 1966-1970 to stand firmly on a wide base of industrial activity can be seen from the following table:

Years	1963	1964	1965	1966	1967	1968	1969	1970
Percentage for demands for tests by scientific institutions to the total demand	71%	75	69	41	14	15	28	17

This change apparently has resulted from the fact that Israel is a small country which absorbed immigrants and refugees from highly developed countries. They found work in the scientific institutions, but there was no basic layer of developed industry to absorb them, and they could not start industries because of their lack of financial means.

What Israel has in common with other less developed countries is the gradual development of industry and the resulting mounting demand for precision work and testing. During the years 1963-1970 the total requests for testing at the Laboratory more than trebled. During the same period, the number of different organizations needing test services rose from about 5 a year to 18 a year, and some made requests more than once in the year.

In the last five years in Israel both precision measuring facilities and the service rendered by the Standards Division have increased. This progress came about with the founding of standards laboratories in institutions and industries which serve satellite organizations. A prominent example is the Israel Aviation Industry (IAI) which established a standards laboratory that serves different companies in the IAI, but tests its own instruments at the Standards Division of the NPLI.

This development was precipitated by foreign companies seeking contracts with IAI and the IAI's consequent need for proof of the adequacy of the existing facilities for precision measurement in Israel. For instance, the Federal Aviation Administration of the USA sent a delegation to examine these facilities in Israel, and visited the Standards Division of the NPLI to check the Division's capability to certify the IAI's instrumentation. As a result, Israel was recognized as an authorized manufacturer of aircraft for the USA market.

Israel has manpower of a high professional level, out of all proportion to its population. A large amount of technical assistance is extended by Israeli experts to less developed countries, although Israel, herself a developing country, still requires advice and assistance in various fields.

3. Metrology Vs. Research

The NPLI has two main areas of activity. One is metrology and the other is applied research. The greater part of the budget and manpower at the NPLI goes to research and only about 10% goes to the Standards Division. Last year (1970) this 10% came to around IL 100,000--i.e. about $30,000.

The rate of industrial development in Israel creates a demand for skilled manpower which sometimes exceeds the supply in scientific and technical fields, although now and then periods of slack in the economy result in an oversupply. This fluctuation is unfortunate for metrology, which requires people with special kinds of talents. They need to be patient, to pay attention to small details, and to perform delicate experimental work. People like this are not easily found in a small country and it takes at least two years to train them adequately. They should be given reasonable remuneration, otherwise they are liable to seek more profitable employment, leaving work interrupted or even paralyzed.

Research institutions are accustomed to dealing with their staffs on the basis that their work is temporary. When the project is completed, the work terminates. This approach is obviously unsuited to workers in metrology. This approach contributed perhaps to the fact that after some time the Standards Division found itself without the necessary staff to operate. In a small country like Israel an erroneous approach to work conditions may influence professionals in scientific and industrial fields, so that it becomes more and more difficult to find new staff. A solution that was suggested to solve the manpower problem, was to change the functions of the Standards Division. Active laboratory service for the aid of industry should be abandoned, it was felt, and the Division should turn into a research and advisory department, not necessarily related to metrology at all. To this author, that solution appears to be like the proverbial throwing away of the baby with the bath water.

4. The Achievement of Accuracy

The swift advance in the world as a whole (and in Israel on a smaller scale) of modern technology, with its profound effect upon industry, has caused an increase in the number of high precision instruments which are sent for testing to the Standards Laboratory. Some people in scientific institutions not directly concerned with metrology believe that since instruments of high accuracy and stability can be readily purchased, there is little need for a Standards Division to do testing and calibrating.

Advocates of this view find support for their opinion in the fact that instruments in the Standards Division such as the gauge-block interferometer or the level comparator, which are used to achieve high order accuracy, are not often used. Therefore the profitability of the work is low, since these high-accuracy instruments are the most expensive kind. What is overlooked is the essential role of these instruments in the testing hierarchy.

It is these misconceptions which have led to the conclusion that the basic problems are shortage of manpower and lack of cost return for metrological work. This argument in turn led to the view that testing, when necessary, should be done abroad. Apart from the expense involved, what is overlooked is the growing demand within Israel's developing economy for services such as those of the Standards Division, and the inadvisability or impossibility of sending delicate instruments abroad for examination. These problems and indeed the whole future of the Standards Division in NPLI are at present under study.

Paper 7.1 - Overview - The Spread of Standardization

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1. Introduction

My assignment for this Seminar is to discuss a broad spectrum of standardization activities with particular concern for the contributions that standardization can make to advances in less developed countries. Since this Seminar is concerned primarily with industrializing economies, this discussion will concentrate on what are called engineering and commodity standards needed by industry, without directing attention to equally important standards needed to protect the safety and general welfare of people, both as individual consumers and in their daily lives in general.

To avoid possible confusion, the terms used in this discussion of standardization are defined in an appendix. These are the definitions of the Department of Commerce Panel on Engineering and Commodity Standards, 1965.

2. Benefits of Standards

As we progress through the range from intra-company, inter-company, intra-industry, national, sub-regional, and regional to international standards, the number of people involved and the special interests that must be reconciled increase greatly. Whatever type of standard is involved the proper aim should be to increase efficiency and economics in production and promote trade involving individuals, companies, and nations. Use of standards to restrict competition or to serve as non-tariff barriers to trade contravenes the proper purpose of standards.

Standards will lower costs of production and make goods more readily acceptable in other countries. Thereby, they will improve the competitive position of developing countries in export markets and thus lead to substantial increases in the purchasing power and general welfare of the people. They will also provide a means of defense against the dumping of sub-standard products unacceptable elsewhere. There are collateral benefits from standardization activities which are likely to be especially important in developing countries. These benefits flow to industry and agriculture through the advances in science and technology required for the development of standards. Furthermore, those affected by the standards are stimulated to greater cooperation in their common interests.

A standard or a specification in which a standard is referenced become a part of an inseparable combination which must include methods of test and a competent laboratory in which the required tests are carried out. Standards are an essential component of the language of business. There must be maximum precision in describing, by reference to an appropriate standard, what the buyer expects to receive and what the seller agrees to furnish. There must also be precision in the description of how compliance with stipulated requirements is to be determined, so that the buyer can confirm that he got what he expected, and so that the seller can be sure that what he furnished is likely to meet the tests that will be applied by the buyer.

This contribution of standards in facilitating and promoting trade extends through the whole spectrum of standardization, from negotiations between individuals or single companies to international trade in raw materials and industrial products. Standards will serve as a guide to developing countries in taking steps to insure that whatever raw materials or manufactured products they wish to export will have the qualities that are required and defined by the standards by which goods are purchased in international markets.

While the contribution of standards to increasing exports of raw materials from "developing" nations is important, users of the term "developing" generally have in mind an increase in industrial activity in the manufacture of goods both for internal consumption and also for export, with consequent improvement in the balance of trade figures. The key to success in this area as shown by experience in highly developed nations and in regional common markets is "mass production." Standards provide an essential basis for mass production. They enable components to be interchangeable in regular production and for replacement when this is needed. They permit manufacture for stock and for a multitude of customers instead of requiring dependence on a number of individual or special orders. They reduce the need for large inventories. Thus they lower the cost of production and the selling price and thereby assist in raising living standards.

3. Organization of Standardization

The facilities required for programs in standardization will naturally vary from what is needed for an intra-company standardization effort to the more complex requirements of national and international standardization. In large corporations the intra-company attention to standardization is put in the hands of specialists who may be called professional standards engineers. These engineers develop, choose and monitor standards used solely within the corporation. They participate in the work of outside organizations in the development of intra-industry, national, and international standards to insure that the products of the corporation will be able to comply with external standards under which they may be purchased. They also guide the purchase of materials by developing specifications in which appropriate standards and methods of determining compliance are referenced, to insure the level of quality that is needed and to take advantage of the lower cost of standard as compared with special items. Standards engineers must work closely with others responsible for quality control within a plant through proper programming of processing, sampling, and inspection to insure that the products will meet internal standards previously established or specified by the purchaser.

Smaller companies are not likely to employ standards engineers defined as such. However, responsibility for attention to standards activities should be specifically assigned under the continuing scrutiny of management at a high level. Even in the smaller company, the importance of standardization should be recognized by top level management, and defined as a specific area of activity rather than something that can be dealt with at a low priority without direct assignment. Those assigned responsibility for standardization should report directly to top management, whatever the size of the company.

External standards used by a company should be regarded as an essential company resource. The sources of such standards should be supported by making technical personnel available for the development of standards that reflect the interest and needs of the company. Also, financial support through dues or by other means must be provided to the national and international organizations in which standards are developed so as to insure that the administration of the activity will be competent, efficient, and continuous.

There is a need also for government support of standardization organizations, particularly in connection with international standardization in which there is an overall national interest and in which it is not practical to identify the interest of individual companies or trade associations for enlisting the necessary support. It is necessary for government agencies to make their reservoir of scientific and engineering personnel available to standards development organizations so as to insure that the total competence of both the government and the private sectors is brought to bear on the development of standards to serve the nation's needs. A prime example of government personnel contributions to the development of standards is provided by the U.S. National Bureau of Standards. A recent survey disclosed that currently more than four hundred members of the NBS staff are serving on committees of private-sector standards organizations in the United States. We must also utilize another source of contributions to the development of standards, the educational institutions, which can provide standards development committees with experts having a general and independent interest and approach different from that of producers and users.

4. Intra-industry Standards

Intra-industry standards are the product of the activities of trade associations, many of which have evolved from old-time guilds. They are composed of corporate and individual members brought together by a common interest. They often include distributors as well as manufacturers. Such groups provide the most effective means for the recognition of need and the development of the engineering and commodity standards required by a particular industry. These standards can define either a manufacturing process or a product.

Trade associations are able to combine the talents and experience of their several members and bring to bear the viewpoints of producers, distributors, and users. They can assemble the funds required for the necessary work on standards, and by combining resources can give each company member the full benefit of the results at only a small fraction of its cost. Standardization activities of trade associations are frequently devoted to matters of prime concern only within an industry, e.g. simplified practices in listing product lines, codes for the identification of products, or the handling and conditions of storage of some basic commodity purchased for further processing. Another example would be a standard for yarn quality used within the textile industry.

5. Standardization in Developing Countries

Intra-industry standards will be needed in developing countries for the purposes that have been described. However, there is a major difference between standardization activities in developing countries and those of highly developed countries. This difference is the role likely to be played by government. Outside the communist area in which standards development and promulgation is largely, if not exclusively, a government activity, the role of the government varies through rather wide limits.

In the United States the development of engineering and commodity standards is initiated almost completely within the private sectors, but with participation by government personnel in the work of the committees of organizations in the private sector. Coordination of this activity and recognition of such standards as national standards is undertaken by the American National Standards Institute, acting as a confederation of the 160 standards-developing organizations which are members of ANSI.

In most other countries, development of national standards is in the hands of national standards bodies which organize committees from both private-sector and government sources to develop the needed standards. Financial support comes from both industry and government in varying

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proportions.

In some developing countries there are native technical societies and trade associations able to develop standards for eventual recognition as national standards. Where such organizations do not exist, the initiative for the creation of a national standardization body and provision for its financing can be expected to come from the government rather than from the private sector, at least until these responsibilities can be undertaken to an increasing extent within the private sector. Since much, if not most, of the non-government competence required for standardization activities will be found in industry and educational institutions, the organization of a national standards body must provide for participation from these elements of the private sector in partnership with government, for both national and international categories of an overall standardization effort.

Appropriate models of effective national standardization bodies can be found among the several members of the International Organization for Standardization (ISO). Those likely to be most appropriate to developing countries can be expected to be found among those country members of ISO in the same general category. Examples include the standards bodies of such countries as Colombia, India, Iran, Israel, and Turkey, listed here alphabetically.

Assistance in the organization of standards bodies of less developed countries has been provided by the United Nations. In Latin America, invaluable help has come from personnel from the U.S. National Bureau of Standards, as illustrated, for example, in Colombia. Here, members of the NBS staff played a major role in setting up the Colombian standards body, ICONTEC. Assistance in training programs was also provided by NBS through the U.S. Agency for International Development (AID), with additional help from the Department of Agriculture and the U.S. Navy. Through the Agency for International Development, the National Bureau of Standards set up a Weights and Measures Laboratory in Bogota for the use of all Latin American countries. Other types of assistance in Latin America have been provided by the Organization of American States and the Alliance for Progress. The Ford Foundation has also given financial assistance to the Pan American Standards Commission (COPANT).

6. Training Programs

Opportunities for training in standardization have been made available by the standards bodies of several highly developed countries. Assistance to standards organizations in Latin America has included the organization, financing, and staffing of seminars for the training of personnel in standards development practices. The NBS has provided experts in the products dealt with in these seminars. Training is being dealt with in ISO through its standing committee for the study of Scientific and Technical Information on standardization (INFCO). This committee is currently compiling a "list of existing specialized educational courses for standardization and a survey of the training facilities at undergraduate and postgraduate levels." Responsibility for this compilation is in the hands of the Polish standards committee.

The United States can provide training programs. These should involve time to be spent at NBS and in such major standards-developing organizations as the American Society for Testing and Materials (ASTM), the Society of Automotive Engineers (SAE) and the American Society of Mechanical Engineers (ASME). Visits should be made to such representative trade associations as the American Iron and Steel Institute (AISI), the American Petroleum Institute (API), and the Copper Development Association.

The operations of a national standards body would be covered in time spent at the American National Standards Institute (ANSI). Intra-company standardization programs could be examined with the cooperation of appropriate large companies which have highly organized standards departments. Organization of such a training program in the United States should be undertaken jointly by NBS and ANSI in collaboration with the other organizations that will be involved including especially AID.

7. Financing

The financing of a national standards body in a less developed country is likely to be the prime responsibility of the government, using funds derived from the private sector by some appropriate means of taxation or assessment. The extent of financing required should be related appropriately to the level of national activity in which standards are important. One measure of such activity could be the Gross National Product (GNP) of the nation. Costs will be affected also by the extent of other activities of the national standards body outside the area of standards for which that body may be made responsible. For example, the body could undertake industrial research as well as standardization and product certification.

In developing countries where the national standards body, at least in its early stages, is likely to be responsible for practically all of the work on standards, on certification, and on testing, plus a good deal of industrial research, an annual budget of from $300 to $400 per million dollars of GNP appears to be appropriate. Lower figures would be expected where exports of foods and other raw materials make up a large percentage of the GNP. Lower figures apply also to highly industrialized nations where much of the standards development work and industrial research is done outside the national standards body. In such cases the figures could range from $2 to $60 per million of GNP.

However a national standards body is organized and financed, it must be able to act as the focal point to identify standards needs, organize the competence to fulfill the needs, independently determine whether standards in fact have national recognition and acceptance--national consensus--and, finally, promote industrial as well as governmental adoption and use of such standards. It must also serve as the official representative of the nation in regional standards organizations such as COPANT and international bodies such as the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

8. Use of Existing Standards

The national standards body of a less developed country can be most effective, especially in its early stages, by taking advantage of what is already available in the vast store of existing national and international standards developed within the more highly developed nations. Included are the food standards covered by the Codex Alimentarius of the FAO and the ECE, which supplement the activities of ISO in this field. In addition to their specific usefulness as standards documents, the existing standards provide a most effective means for transfer of technology in an immediately useable form.

In the international field there are already over 2000 international recommendations from ISO and IEC to draw upon. In the national field there are as many as 20,000 standards in a single country, many of which will eventually be succeeded by international standards but which in the interim are available for guidance. An appropriate first step would be to prepare a list of standards for which the need is most urgent, arrange these in a proper order of priority, and then make a choice from those available that are judged to be most appropriate for local use. Necessary modifications may be made to deal with special circumstances and capabilities of compliance. Currently ISO is engaged in cataloguing available standards as a guide to less developed countries and others as to what is immediately available. This will supplement similar catalogues maintained by the national standards bodies of several countries, one being a computerized catalogue established by NBS.

Development of unique national standards from scratch in less developed countries should ordinarily represent a minor portion of the total activity. It should be undertaken only with competent advice and assistance and in response to special needs that cannot be dealt with by the use of available standards from external sources with such modification as may be appropriate. The standards bodies of less developed countries should become members of regional and international standards organizations and participate in their standards development activities at least as observers, so as to insure that their special interests will be taken into account in the development of international standards with which the products of these countries may be required to comply in international trade.

International standardization, on at least a regional level, must be recognized as an essential component of any program leading to the establishment of a regional common market. This will be necessary to insure that incompatible national standards will not contravene the objectives of unobstructed trade among participating countries which is the principal goal of any common market. The organization of sub-regional standards organizations may be desirable as a step in the progression from national standards to international standards. ICAITI in Central America provides a good example. However, a sub-regional organization should cooperate with an existing regional standardization body and not become competitive with it. This would represent undesirable dilution of the total effort for which technical resources and financial support may be limited.

The ultimate goal for all nations, whether less or highly developed, should be eventual substitution of international standards for national standards, realizing this as a major contribution to the promotion of trade, interdependence, and peace among all the nations of the world.

Appendix

Definitions from the Report of the Panel on Engineering and Commodity Standards of the Commerce Technical Advisory Board, PB166811A&B, National Technical Information Service, Springfield, Virginia 22151.

Standard -

A document or an object for physical comparison to define properties, processes, materials, relationships, concepts, nomenclature or test methods. When used as an adjective, distinguishes something that is common and regularly available from something that is special or that is "made to order."

Specification -

A document setting forth in detail pertinent defining characteristics of a product such as performance, chemical composition, physical properties, dimensions, color, etc., giving or referencing the standards by which the correspondence to the defined characteristics is to be measured; and prepared for use in, or to form the basis for, an agreement between negotiating parties.

Code -

A document setting forth requirements based on certain considerations, frequently health and safety, and the criteria and standards against which compliance with the requirements is to be measured.

Consensus -

In standardization practice a consensus is achieved when substantial agreement is reached by concerned interests according to the judgment of a duly appointed and recognized authority. A principal function of a national standardization body is to provide a means "as the recognized authority" for achieving a consensus, taking into account a balanced interest through expression of views of all likely to be affected including producers, users and those having a general interest.

Simplified Practice -

This refers to the process of reducing the number of types of products made (or called for) within a definite range. This generally involves more than one firm and is often adopted within an industry or major section of one.

Paper 7.2 - Overview - The Role of Standardization in Industrializing Economies

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1. Introduction

In presenting this overall review of the role of standardization in industrializing economy, I have made only passing reference to the work on metrology--fundamental standards of weights and measures--since in India the work on standardization like that done by the National Bureau of Standards (NBS) is carried out by two different organizations. The National Physical Laboratory (NPL) concerns itself with maintaining fundamental standards of measurement,and work on industrial standardization is undertaken by the Indian Standards Institution (ISI).

Standardization is not a modern invention. It expresses a basic human instinct to create order out of chaos. The development of language for communication among human beings is an example of standardization from the earliest times. As civilization advanced, man discovered methods of measuring distance, weight, and time, and instruments for these. He produced tools and utensils designed for specific uses. He has developed trade by exchanging goods and services and established methods to judge their quality and price. All these are aspects of what we call standardization today. The essential difference between the standards of the past and of the modern industrial era lies not so much in their nature as in the highly organized pattern that standards work has assumed in this century. Today the rate of industrial progress and the tremendous upsurge in international trade make it essential to plan the development and application of standards both at the national and international levels.

Standards deal with all the characteristics of products, services and manufacturing processes on which it is essential to reach national agreement in the interests of improved productivity. They may be grouped into:

(i) Basic Standards - Terminology, units, symbols, methods of measurement, preferred numbers, documentation, classification and coding.

(ii) Applied Standards - Dimensions, product, quality and "fitness for purpose"; physical, mechanical, and chemical methods of test; methods of sampling and quality control; acceptance tests; safety standards; codes of good practice for building, installation, and maintenance.

All these standards are essential tools for designer, manufacturer, buyer and research worker.

2. Principles of Standardization

The basic principles and purpose of standardization remain the same whether standardization is introduced in a more or a less developed country. The following definitions accepted by the International Organization for Standardization (ISO) make this point evident:

a) Standardization - Standardization is the process of formulating and applying rules for an orderly approach to a specific activity for the benefit and with the cooperation of all concerned, and in particular, for the promotion of optimum overall economy taking due account of functional conditions and safety requirements.

It is based on the consolidated results of science, technology and experience. It determines not only the basis for present but also for future development, and it should keep pace with advances. Some particular applications:

i) units of measurement;

ii) terminology and symbolic representation;

iii) safety of persons and goods.

b) Standard - A standard is the result of a particular standardization effort, approved by a recognized authority. It may take the form of:

i) a document containing a set of conditions to be fulfilled;

ii) a fundamental unit or physical constant--examples: ampere, absolute zero (kelvin);

iii) an object for physical comparison--example: a metre bar.

In case of a fundamental unit or physical constant or an object for physical comparison like the metre, the task of this sort of standardization in India is shared by the ISI and the NPL. The NPL is the custodian of the metrological standards which in this country come under the purview of the NBS. The responsibility of the ISI, like the British Standards Institution, is confined to the preparation of standards for weights and measures used in commercial transactions. The custodian of the primary weights is the NPL.

During its work of preparation of national standards, ISI has been responsible for the preparation of a large number of standards on weights and measures including the balances which are given in Annexure II. In case of instruments which fall under various engineering disciplines tackled by the ISI, standards have been prepared for precision and performance, and these are also listed in Annexure II. Belonging as I do to the ISI, I would refrain from talking to this informed audience any more about the work of metrology carried out by the NPL. The association of the NPL (India) with NBS has been so close as to require no repetition on this forum.

The field of standardization is represented in Figure 1 by a hypothetical standardization space. The three dimensions of this space are "subject", "aspect", and "level."

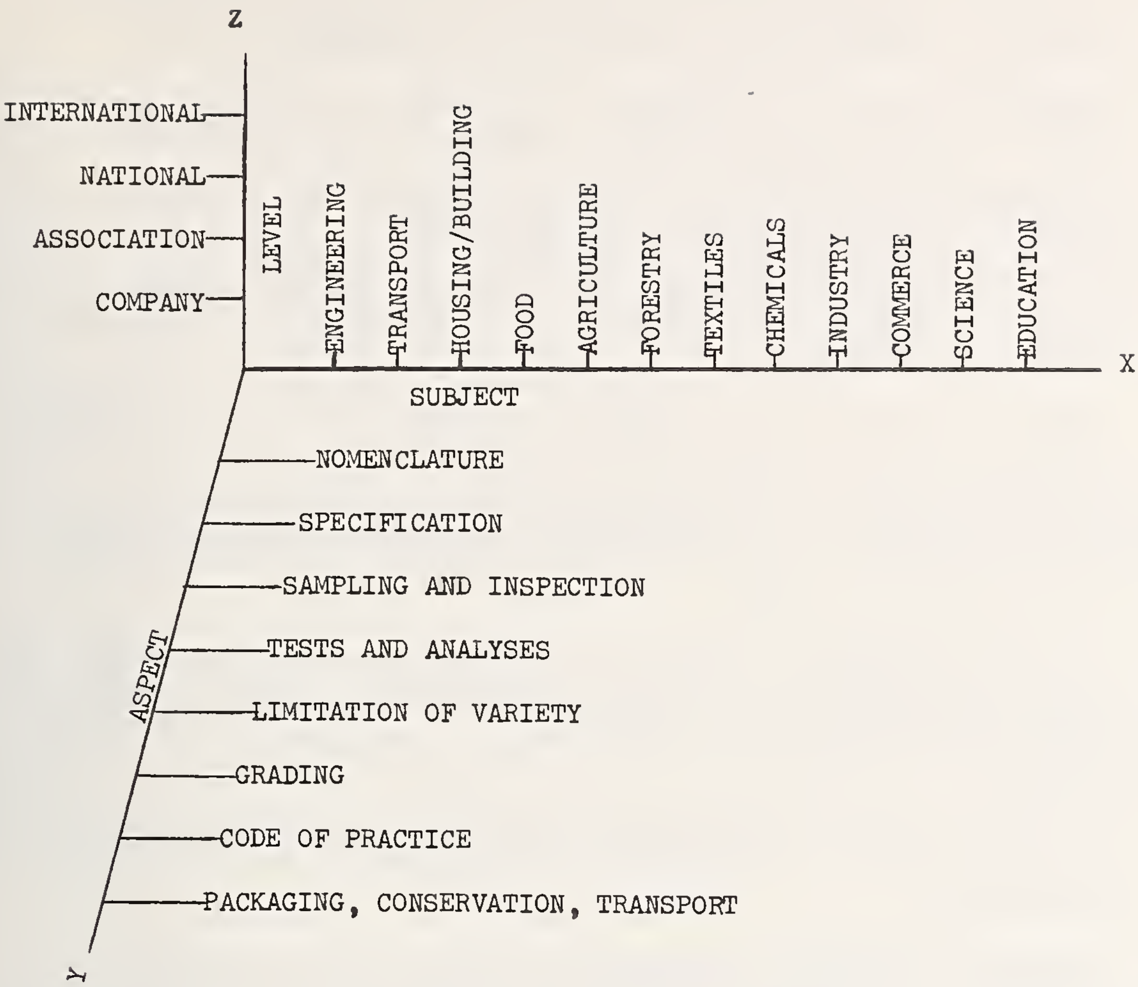

Figure 1

Diagrammatic Representation of Standardization Space

X) Standardization Subject- Standardization subjects are material things, abstract notions, formal symbols, etc., which are suitable for being standardized. Some examples of standardization domains are: engineering, transport, housing and building, food, agriculture, forestry, textiles, chemicals, industry, commerce, science, and education. Since there are many standardization subjects for each standardization domain, for the sake of convenience only the domains are indicated on the X-axis of Figure 1.

Y) Standardization Aspect - Examples of standardization aspects are:

i) a set of nomenclatures or definitions of terms;

ii) a scheme for limitation of variety or sizes, shapes, grades or other parameters designed to meet most economically the needs of the consumer (also including dimensional freezing of component designs to ensure interchangeability);

iii) construction details;

iv) a specification for quality, composition or performance of a material, an instrument, a machine or a structure;

v) a method of sampling or inspection to determine conformity to a specified requirement of a large batch or lot of material or products by inspection of sample;

vi) a method of test or analysis to evaluate specified characteristics of a material or chemical;

vii) a method of grading and grade definitions for natural products, such as timber, minerals, etc;

viii) a code of practice dealing with design, construction, operation, safety, maintenance of a building, an installation, or a machine;

ix) a code of practice for packing, conservation or transportation of materials and products.

Z) Standardization Level - A standardization level defines a group of persons who are to use the standard. Standards corresponding to the more important levels occurring in contemporary practice may be classified as follows:

i) a company standard, prepared by common agreement between various departments of a company or production unit for guiding its purchase, manufacture, sales, and other operations;

ii) an association or trade standard prepared by a group of related interests in a given industry or within a given profession;

iii) a national standard promulgated after consulting all interests concerned, however remotely, with the subject in a country, through a national standards organization which may be a governmental, a non-governmental, or a quasi-governmental body;

iv) an international recommendation or standard, such as those of the ISO and the International Electrotechnical Commission (IEC), resulting from an international agreement between independent sovereign nations having common interests.

For a given standardization problem, it is possible to establish the specific aims of standardization by determining its position in the standardization space. However, the ultimate aims of standardization are applicable to all levels, though a distinct functional character may be ascribed to standard at each specific level.

The aims of standardization in general, applicable to all levels, are to achieve: (a) overall economy, (b) protection of consumers' interests, and (c) safety and protection of health and life.

a) Overall Economy - comprises economy of human effort, materials and machines, power and energy, on the one hand, and the combined economy of the producer and the consumer on the other. The attainment of overall economy creates maximum productivity for the country as a whole, though the economy of each individual unit or component of production may not be at an optimum level. For example, greatest economy in material may preclude greatest economy in labor. The pursuit of overall economy results in simplification and reduction of variety of products and components, and elimination of avoidable wastage during handling of materials, processing, transport, and in general exchange of goods and services. Sometimes, it involves saving of essential materials by substitution with more readily available materials which may or may not lead to immediate or apparent saving in cost or human effort, but which, in the national economy, may be essential for other important reasons.

b) Protection of Consumers' Interest - is ensured through adequate and consistent quality of goods and services. The notion of quality of service covers not only material services such as the attainment of higher quality or performance or functional interchangeability of consumer articles, but also non-material services and conveniences, such as ready availability of standard goods from stock, simplicity coupled with serviceability of consumer equipment, and generally such things as make man's life and work easier, more effective, and pleasant.

c) Safety and Protection of Health and Life - may concern goods in general use or material or processes during production. Examples are standards for limiting impurities in foodstuffs, standards for storage of radioactive materials, and regulations for earthing (grounding) of electrical wiring and equipment.

To achieve these aims is, in a way, to introduce order into industry, trade and commerce, and in human relationships generally. An eminent Indian thinker said that standardization is to industry and commerce what culture is to society. In other words, just as rules of civilized behavior regulate the social intercourse of man and his appreciation of cultural values, so does standardization help to regulate the conduct of commerce and trade in a smooth and efficient manner, and assist in improving productivity and efficiency of man and machine.

3. Applicability of Standardization in Developing Economies

The creation of a dynamic society from limited resources and often under severe population pressure usually involves national planning, direction, and control to an extent hardly compatible with the laissez-faire economy of the last century. It is in the context of such planned development that the role of standardization in a developing economy has to be evaluated.

Standards come into play whenever there is transition from production to consumption, since they establish a link between the two. The transition from production to consumption occurs not only at the ultimate point of use, but also at a number of intermediary stages, both in industry and trade. The growth of industry in any country is marked by a corresponding rise in the interdependence of the different productive sectors. Each has to look to others for the supply of raw materials, machinery, components, and services; and each, in turn, provides similar facilities to others. The resulting complex relationship cannot be sustained unless adequate understanding of the products and processes involved is achieved at the innumerable contact points at which products pass from one plant to another, or from store to householder, or for that matter from one country to another. One of the main functions of standards is to facilitate the flow of products through these transition points.

Apart from helping commercial movement and industrial exchanges in this manner, standards, as has been pointed out earlier, also conserve productive effort by reducing unnecessary variety, by ensuring interchangeability and making mass production possible. Thus, standards lead to the best utilization of the human and material resources of a country. For a developing country, the conservation of resources and achievement of a high level of productivity are of obvious importance. So is the need to expand exports to earn foreign exchange with which to provide for the growing necessity for importing capital equipment, so essential at the initial stages of development.

In a developing economy, industrial development is often dependent on outside assistance in the form of technical personnel, industrial know-how, capital equipment, and so on, which may be extended by different industrial groups in different countries. Thus, production units in a developing country may tend to adopt and follow the pattern of standardization of the different collaborating organizations abroad. This is the time when national standards are most urgently needed and when, more often than not, they are conspicuous by their absence. Hence the prime need for a developing country is to bring into being a system of national standards, which would help industries from the earliest stage of planning and design, through erection, production, and distribution. It is through such an approach that the usually limited financial resources of a developing country and its indigenous materials and manpower could most effectively be put to work.

4. Planning in Standardization

In industrializing economies it would be extremely useful to have standards before industrialization begins or even during the early period of industrialization. The value of pre-planning in standardization is illustrated in an Indian example. The ISI was established in 1947 when the country did not have many industries. Later industrial development took place on a planned basis from 1950 onwards but before then the ISI had already done most of the spadework required for laying a foundation for a strong industrial base. As the country went from plan to plan, ISI had its own Five-Year Plans dovetailed with the national plans so that it was possible to meet the demand for standards in accordance with the priorities of the plan. Today the ISI is in a position not only to guide existing industries in their efforts to rationalize their production and institute quality control, but also to help in planning future industries and in organizing export promotion measures.

As an example of the value of pre-planning of standardization, experience of the Steel Economy Project of the ISI may be cited. The aim of this project was to achieve economy in the use of structural steel by adopting standards from the stage of production of structurals through designing, fabricating and erecting to the maintenance of structures. In production, considerable emphasis was laid on rationalization of shapes and sizes of sections, although these designs had been frozen years ago. The development of new standard sections by the ISI permitted saving about 10 percent on steel. All new mills installed in recent years in India or to be installed in the future are to produce these new sections. Cold-formed sections made from strip are now being standardized; it is estimated that this will permit saving up to 40 percent of the material. Standards for welding equipment and accessories and codes for welding practices have been developed to provide further economies on steel by eliminating the wasteful process of fabrication involved in riveting. Similarly, improved design codes for steel structures now enable Indian engineers to use more rational safety factors and loading criteria and permit the use of more economical and up-to-date formulae for design.

It is conservatively estimated that about 20 percent of steel might be saved if all similar measures now available to the engineer were fully implemented. In the context of a production of steel of ten million tons a year, an appreciable quantity of which is used for structural purposes, a reduction of even one million tons per year would yield a recurring saving of well over 100 million dollars, let alone all the investments, costs, and efforts involved in the production of this extra quantity.

A part of the steel economy project was concerned with the rationalization of the varieties of alloy and special steels required for miscellaneous industrial uses. The import to India of equipment and expert knowledge from all parts of the world had generated a demand for well over one thousand types of alloy and special steels, including tool steels. This was not only wasteful but also precluded the possibility of developing indigenous production, which would be extremely uneconomical in view of the limited demand for each type of steel. After an extensive study, it proved possible to reduce varieties to some 130 types, to minimize the use of imported alloying elements, such as nickel and molybdenum, and to encourage the use of indigenously available alloying elements such as manganese and chromium. The project made it possible to plan the establishment of several new alloy steel plants, a number of which are currently under construction.

The question may be raised why national standards should be developed instead of adopting international standards or those evolved in other countries. Before answering this question, it should be pointed out that standards, whether at a national or other level, should be developed only if they serve a common need and are likely to contribute to the overall economy of the nation or other group or sector concerned. Once this condition is fulfilled, the answer to the question becomes obvious, namely, if an available international standard or one developed in another country may serve the interest of a particular nation, then there should be no hesitation in adopting that standard, for in the long run it is going to facilitate international coordination of standards and save a great deal of unnecessary duplication of effort. However, in adopting an outside standard, it may become necessary to make one or more minor or major changes dictated by the special conditions under which the national economy concerned operates. There are many cases in which neither national nor overseas standards exist and other instances in which they do exist, but must be considered inadequate for the intended purpose. Under both circumstances, it becomes necessary to evolve independent national standards.

This point may be illustrated by a few examples from the Indian experience. Before the ISI came into being, the prevailing industrial practices in certain well-established industries such as cement, steel, and non-ferrous metals, were largely based on British standards. Though by and large the British standards covered India's needs, it became apparent that these standards should be amended in order to meet certain specific needs of the country, in particular in respect to indigenous raw material resources. Thus, in the case of steel used for statically loaded structures, the content of sulphur and phosphorus impurities had to be relaxed so that, given the available resources of coking coal, production of steel in the country could be stepped up to meet the ever-increasing demand. In the case of Portland cement, the existing specifications had to be liberalized in respect of magnesia content so that a large number of limestone deposits in the country could be economically exploited for the manufacture of cement. Before these decisions were taken, experimental investigations and a search of overseas standards were undertaken to ensure that such liberalizations would not in any way affect the basic qualities required in the products.

5. Needs of Less Developed Countries

The extent and content of national standards are a characteristic of the development of industry in a country. Well organized standardization is an indicator of industrial efficiency and productivity. The store of concentrated and carefully collated knowledge and experience expressed in any standard specification, indigenous or foreign, is of great value to emerging countries in planning their economic development at a fast pace and with the least wastage. For their domestic production, the developing countries often give priority to standards for primary products and industrial raw materials since these form the basis of their production. Less developed countries, however, are also large purchasers of equipment from those technically advanced countries with whose collaboration they often set up industrial plants. The recommendations published by ISO and IEC should enable the less developed countries to start their standardization organizations in improving the quality of their production and in general attaining the economic advantages that accrue from such effort. However, the recommendations of ISO and IEC should be so formulated to be truly international in the sense that their coverage is world-wide. I may recall to your minds the ISO's own definition of standardization: it is "for the benefit of all and with the cooperation of all concerned for the promotion of optimum overall economy...." At the present time not all the nations of the world participate in the world standards preparation nor does the mechanism exist for them to do so. Like it or not, ISO and IEC recommendations are oriented toward the more highly developed countries and hardly take full consideration of conditions--environmental, technological and economic--that are prevalent in the large areas of the world inhabited by underdeveloped and backward countries.

A little-developed country has to safeguard its interests in international standardization as much as any other country. Special requirements, to suit its state of industrial development, climatic conditions, material resources and so on, need to be built into industrial recommendations through the action of the relevant committees. An example is provided in the tropical and sub-tropical standard atmosphere for testing, so often used for conditioning samples of materials prior to the specification tests applied for proving their compliance. In the beginning the atmospheres considered for adoption by ISO and IEC were those widely used in Europe and the USA. These were unsuitable for tropical and sub-tropical regions where temperatures are much higher during most of the year. If European standards were adopted in these regions, testing laboratories would have to maintain costly installations for air-conditioning. On a proposal by ISI, a third atmosphere for tropical conditions has been accepted by ISO and IEC. This step is of importance to many developing countries in the tropical region since it enables all materials and commodities for tropical use and export from the tropics to be tested in all countries under the most suitable internationally recognized set of atmospheric conditions.

Many similar problems of the tropical and sub-tropical regions of the world as well as primary raw material production industries of the developing areas have to be given more consideration in the ISO and IEC work than has been done hitherto. In this task the major role has to be played by the less developed countries themselves through their national standards bodies, which have to be established with foreign help.

6. Problems of Less Developed Countries

The nature and type of assistance required for developing countries may be expected to vary according to the stage of development which a country has reached. There are certain countries in early stages of development where little has been done for planning of standardization activity; there are others where the value of starting a standardization movement has been recognized and some great steps taken. There are yet others where very significant progress has been made towards industrialization and standardization. While different kinds of help would be required for each of these organizations, I could say, speaking on behalf of India, that she could render help in an urgently needed international effort for training standards personnel. There is a shortage of scientists and engineers in most of the developing countries, and standardization being a new discipline has not yet found a place in the curricula of technical institutions. In order to tide over the difficulties faced in India for getting the right type of personnel, the ISI initiated in 1957 a two-year training program for its own newly recruited technical personnel. This consisted of 2 to 4 months of induction, 4 to 5 months of lectures and discussions, 5 to 6 months of factory visits and in-plant training, and 11 to 12 months of on-the-job practical training within the Secretariat of the standardization committees of the Institution. This program was regularly repeated once in two years, but more recently its duration has been reduced to one year. Initially, these training programs suitably abridged were offered to participants from a number of developing countries. ISI training efforts in standardization are summarized in Annexure I.

There is another program exclusively for foreign participants which has been organized from 11 January this year in which 14 trainees from the following countries are taking part: Aden, Ceylon, Ghana, Kenya, Malaysia, Nigeria, Philippines, Egypt, and Zambia.

In order to help the developing countries better, the Indian Government has sent a proposal to the United Nations asking financial assistance for strengthening the training course. This proposal has not yet matured but this would be one of the areas in which the United States Government's help would be useful to the less developed countries. This should be on the basis of a matching grant to be provided by the ISI.

Another way in which less developed countries could be helped would be by providing fellowships of suitable amounts for training in standardization in more highly developed countries such as the USA, India, Japan or Germany. Such fellowships could be offered to eligible standards engineers from less developed countries so that on their return to their countries, they could utilize the knowledge gained. This could cover all disciplines including mechanical engineering, civil engineering, electrical engineering, instrumentation technology, and so on.

Another important problem facing less developed countries is the lack of testing facilities for products manufactured by small scale industrialists. Unless the standards that are prepared could be utilized by the industry concerned, and the know-how made available and the testing facilities provided at all important centers, it is not possible for small industries to come up to the standards. Forty percent of the industries in our country for instance are in the small-scale sector. In times to come there are bound to be more of them and this has great employment potential. It is felt that the NBS could organize the help for establishing test houses on a self-help-cum-aid basis in less developed countries. These funds could be advanced through an appropriate organization such as the national standards bodies.

Standardization is predominantly a cooperative venture, whether on the company, association, national, or international level. In the international field cooperation must be sought and obtained from all the nations. To give that cooperation all nations of the world must be guided and helped to take interest in the standardization movement--first at the national level, then at the international level. Here I would like to appeal to progressive nations in the world to lead the way and help less developed countries to progress.

USA is today the world's most advanced nation and this position she owes to the American pioneering Pilgrim fathers. The Pilgrim fathers always looked forward and never rested, but kept on widening their frontiers step by step. Today the whole world looks to you to take the rest of the world forward. Let me end this dissertation by quoting to you, members of a new nation, from the scriptures of one of the oldest--India--the message of the need for forward motion:

> Those who sit, their fortune sits;
> They that stand up, their fortune gets up;
> The sleepers, fortune also sleeps,
> Those who move, their fortune also leaps forward.

So keep moving, be dynamic.

Annexure I

Training Programs In Standardization Organized by ISI

Program in Year	Participants: ISI Officers	Participants: Overseas		Duration of Program
1958	39		-	2 years
1959	28		-	2 years
1961	16		-	2 years
1964	30	Philippines Singapore Thailand	2 3 2	2 years (16 weeks for overseas participants)
1965	-	Ceylon	2	8 weeks
1966	48	Philippines Thailand UAR	3 2 3	2 years (16 weeks for overseas participants)
1968	-	Philippines Thailand	2 1	15 weeks
1969	-	Burma Ceylon Philippines South Yemen UAR	2 1 1 1 4	15 weeks
1970	-	Ceylon Kenya Malaysia Thailand UAR	1 1 1 1 4	15 weeks
	161		37	

Annexure II

List of Indian National Standards

Optical and Mathematical Instruments

IS:	
988-1959	General requirements for optical components
1360-1963	Engineers' pattern tee-squares
1399-1959	Glossary of terms used in optical technology
1480-1960	Metric scales for general purposes
1481-1961	Metric steel scales for engineers
1482-1960	Metric scales for use with drafting machines
1491-1959	Metric scales for architectural purposes
1492-1959	Metric surveying chains
1561-1962	Set-squares for use of drawing offices

1562-1962	Metric diagonal scales (Cartographers, surveyors and engineers)
1563-1963	Protractors for use of drawing offices
1632-1960	Bubbles
1764-1961	Trough compass
1779-1961	4-Metre, levelling staff, folding type
1955-1961	Prismatic compass, liquid
1957-1961	Prismatic compasses, non-liquid
2233-1962	Straight-edges for drawing office use
2286-1963	Pantograph
2352-1963	Procedure for basic climatic and durability tests for optical instruments
2466-1963	Beam compasses
2533-1963	Geometry boxes
2539-1963	Plane tables
2666-1963	Slide rules (linear type)
2754-1964	General requirements for optical instruments
2976-1964	Optical theodolite
2988-1965	Vernier theodolite
3099-1965	Slides and cover slips for microscopes
3113-1965	Prismatic binoculars for common use
3135-1965	Cathetometer
3206-1965	Engineers' drawing instruments, dividers
3207-1965	Engineers' drawing instruments, rotating compasses
3208-1965	Engineers' drawing instruments, half set of compasses
3209-1965	Engineers' drawing instruments, spring bow compasses
3283-1968	Parallel rulers, 150 mm (link type)
3602-1966	Recommendations for the design of scales and indexes for indicating instruments for scales of 1 to 2 percent resolution
3686-1966	Student type microscope
4328-1967	Monocular dissecting microscope
4329-1967	Measuring (travelling) microscope
4380-1967	Abney level
4381-1967	Pathological microscope
4590-1967	Engineers' levels
5153-1969	Proportional compasses - 150 mm, 200 mm and 300 mm
5148-1969	Hand magnifiers: 50 mm, 75 mm, and 100 mm
5146-1969	Sounding sextant
5147-1969	Examination lamp with bull's eye condenser (floor model)
5204-1969	Research microscope
5205-1969	Drawing pins
5213-1969	French curves for drawing office use
5415-1969	Code of practice for packing and packaging of optical and mathematical instruments and components
5694-1970	Engineers' drawing instruments, dotting pens
5695-1970	Spectacle lenses
--	Tangent clinometer
--	Engineers' drawing instruments, curve pens
--	Engineers' drawing instruments, bordering pens
--	Sigmoidoscopes
--	Cystoscope
--	Recommendations for the preparation of drawings for optical elements and systems
--	Spirit levels for use in precision engineering

Industrial Instruments

IS:

3624-1966	Bourdon-tube pressure and vacuum gauges
3944-1966	Flow cups

Meteorological Instruments

IS:

4849-1968	Rain measures

452-533 O - 72 - 16

5225-1969	Rain gauge, non-recording
5235-1969	Rain gauge, recording
--	Whirling psychrometers
--	Thermometer screens
--	Pan evaporimeter
--	Thermograph, bimetallic
--	Aneroid barometers
--	Hair hygrograph
--	Barograph, aneroid
--	Anemometer, cup counter
--	Windvane
--	Mercury barometer
--	Clock mechanisms and drum for meteorological instruments
--	Charts for recording meteorological instruments

Laboratory Apparatus for Dairy Products

IS:	
1183-1965	Density hydrometers for use in milk (revised)
1223-1958	Apparatus for the determination of fat in whole milk, evaporated (unsweetened) milk, separated milk, skim milk, butter-milk and cream by the Gerber method
2311-1962	Fat extraction apparatus for milk and milk products
2803-1964	Capillary pipette for direct microscopic count of milk
3864-1966	Mobile kit for testing milk

Laboratory Glassware and Related Apparatus

IS:	
878-1956	Graduated measuring cylinders
915-1958	One-mark graduated flasks
1117-1958	One-mark pipettes
1381-1959	Boiling flasks (narrow-necked)
1388-1959	Reagent bottles
1541-1959	Glass filter funnels
1574-1960	Glass weighing bottles
1575-1960	Separating funnels
1590-1960	Glass filter flasks
1672-1967	Floating dairy thermometers (first revision)
1996-1962	Glass stopcocks
1997-1967	Burettes (first revision)
2480-1964	General purpose glass thermometers
2618-1963	Test tubes
2619-1963	Glass beakers
2620-1963	Distilling flasks
2626-1963	Petri dishes
2627-1963	Glossary of terms relating to liquid-in-glass thermometers
3055-1965	Clinical thermometers
3104-1965	Density hydrometers
3608-1966	Glass alcoholometers
4161-1967	Nessler cylinders
4162-1967	Graduated pipettes
4426-1967	Methods of sampling laboratory glassware and medical glass instruments
4529-1968	Glass tubes for medical thermometers
4825-1968	Laboratory and reference thermometers
4849-1968	Rain measures
4610-1968	Glass tubes for general purpose and reference thermometers
--	Interchangeable conical ground glass joints
--	Dry and wet bulb hygrometer and curometer
--	Tables for calibration and methods of verification of volumetric glassware

Electronic Equipment

IS:

2711-1966	Direct reading pH meters (revised)
3437-1966	General requirements for electronic voltmeter (pointer indicator type)
4309-1967	Methods of measurements on direct reading pH meters

Acoustics

IS:

3931-1966	Sound level meters for the measurement of noise emitted by motor vehicles
3932-1966	Sound level meters for general purpose use
4482-1967	Specification for hearing aids

Cinematographic Equipment

IS:

4495-1968	Methods of measurement of light output of cinematograph projectors (for narrow gauge film)
4496-1968	Screen luminance for projection of 16 mm film by incandescent lamps
4497-1968	16mm portable sound-and-picture cinematograph projectors

Integrating Electrical Meters

IS:

722(Part I)-1962	AC electricity meters; Part I general requirements (revised)
722(Part II)-1962	AC electricity meters: Part II single-phase 2-wire whole-current watt-hour meters (revised)
722(Part III)-1966	AC electricity meters: Part III three-phase whole-current and transformer-operated meters, and single-phase two-wire transformer-operated meters (revised)
722(Part IV)-1966	AC electricity meters: Part IV three-phase watt-hour meters with maximum demand indicator (revised)
722(Part V)-1965	AC electricity meters: Part V voltampere-hour meters for restricted power-factor range
722(Part VI)-1968	AC electricity meters: Part VI, Var-hour meters
7766-1961	Time switches

Paper 7.3 - Weights and Measures Standards: Laws, Inspection, Enforcement

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It is an honor and privilege for me to be one of the speakers at this important seminar. I sincerely hope that my contribution will positively serve its theme and valuable aims. Having worked in the fields of standardization and metrology during the last two decades, I may be able to point out for the distinguished participants some of the basic problems and difficulties encountered by developing countries, especially those whom I am now serving in the framework of the Arab Organization for Standardization and Metrology (ASMO). This organization was established three years ago as a specialized agency of the League of Arab States.

I. Evolution and Aspects of Metrology

Many countries are now striving to develop their metrology systems, so as to keep pace with recent advancements and developments. Some of these countries were considered in ancient days as pioneers in this field. This has been clearly proved by various ancient Egyptian, Sumarian, Babylonian and Phoenician sculptures and writings, as well as by many phrases in the Holy Books.

On such historical evidence, the objective of establishing and maintaining standards for measurement is as ancient as the art of measurement itself, which is already very old. When the problem of establishing a measuring system first arose, the primary standard was taken as a magnitude of nature itself. Later it became clear that nearly everything in nature is subject to changes, and natural standards cannot conveniently be used in direct measurements. Thus, it was found necessary to make copies of the natural standards. To overcome the problem of deviation, the most accurate copy of a primary standard was chosen and kept in the Temple of the State as a holy measure for reference. Hence, natural standards were discarded gradually, and their copies replaced them everywhere.

Through successive ages, a diversity of standards and systems of measurement developed. Then, with the advance of the industrial revolution, the growth of science and technology and the complexity of commercial relations, the fundamental necessity for organizing the chaos in such an important field became more and more evident. Successful efforts in that direction resulted in the adoption of the foot-pound system by many countries, then the metric system followed and later the SI system.

The evolution and recent development of metrology has provided mankind with an elaborate science and technique for measurement. It became possible for weights and measures to be much more precisely based, conforming to greater exigencies of accuracy and reproducibility, which are essential for modern technology and the ramifications of industry and commerce.

The fundamental functions and applications of scientific applied and legal metrology have also proved the basic importance of metrology in the promotion and development of both national and world economy. It has also become quite evident that the future level of advancement in any country depends on the scope and thoroughness of metrology arrangements. Hence, in practically every country the state takes the responsibility of making the necessary basic provisions to enable exact measurements to be carried out in all activities where measurement is needed. Starting from well-defined principles and recognized standards, these provisions and arrangements include the establishment or realization, the custody and maintenance of primary standards of fundamental physical units such as those for length, mass, time, temperature, etc. These standards must meet the highest national levels and must be properly linked scientifically on the international level. These responsibilities are entrusted in advanced and in some developing countries to a central government laboratory or other authorized institute well equipped for scientific metrology. The second aspect of such arrangements is concerned with the application of the various units of weights and measures through relatively simple instruments of measurement, and by other appropriate means, to all the different everyday requirements of commerce and production. For the marketplace, and in manufacture and repair, there is need for utilization of weights and measures whose values have been certified. There is also need for practical methods of measurement which are rapid and simple but whose reliability is certified, though at lower levels of accuracy. The range of this so-called applied metrology is however very wide, because it can extend from quite highly sophisticated industrial and technological measurements down to weights and measures used in the village shop.

In most countries, the state endeavors to insure that weights and measures and methods of measurement used in industry and trade are derived and properly related to the national standards, and that they are within prescribed limits of error. For these purposes regulations are required for the control of exported or locally produced weights and measures, for instruments and for their primary and periodic calibration under law. Such applied metrology, being practiced under law, is usually called legal metrology. This paper deals mainly with the most important problems which usually face developing countries when either starting or developing legal metrology activities.

II. Main Problems Encountered by Developing Countries in the Field of Legal Metrology

The progress of developing countries and the fulfillment of their hopes depends largely on rapid economic growth, which in turn is rarely attainable by the marketing of raw materials or agricultural products alone. Most developing countries are fully aware that rapid industrialization is a prerequisite for achieving development through the manufacture of goods both for domestic consumption and, wherever possible, for export. To face competition in world markets, it is essential that the locally produced goods conform to defined standards of quality and uniformity. Quality control is thus very much an urgent governmental concern. It implies accurate reference to a well-defined measurement system, which is also essential for production itself. Furthermore, a workable arrangement for weights and measures control is necessary for industry and commerce in all countries. Effective machinery for weights and measures control, based on well-defined units, legislation and standardized methods of measurement is therefore an urgent necessity.

The establishment of such a machinery and its efficient running in developing countries is usually faced by some problems. Probably the most important problem faced by many of these countries is the lack of a uniform system of basic units. Instead, there exists, in some of them, a diversity of types of weights and measures. The units and their denominations may also differ for different products and in different parts of the country. Often the units vary from locality to locality. Thus, there coexists a variety of units with different values, causing difficulties and confusion.

The establishment of a single uniform system, and the conversion to the metric or SI system have been and still are being experienced by many of these countries. What is required is technical assistance, to those countries which need it, for planning and organizing a conversion to or implementation of a single unified system where none exists already. This technical assistance should cover any or all of the aspects, from preparing the preliminary overall plan, estimating the cost of the changeover, finalizing of a firmly phased orderly program, providing of conversion tables and other literature, training of personnel, providing material, advice, and assistance during the legislation and implementation phase, and so on.

The exact scope of assistance should be determined after ascertaining the needs of the particular country, its stage of development, and its available potentialities. That is why this important task was given first priority in the work program of ASMO. A comprehensive survey of the existing potentialities as well as the urgent requirements of its member Arab States in the field of legal metrology began a few months ago with the assistance of both UNIDO and UNESCO. The analysis and assessment of the survey results is expected to serve in formulating suitable development programs on either a national or regional basis, and also in defining the technical assistance required from either specialized international bodies or advanced national institutes.

The second problem is mainly that of lack of facilities for the manufacture and repair of scientific instruments, including measuring instruments, except the very simple ones, required for metrology. Fortunately some of the routine instruments required in large quantities for legal metrology are relatively simple; their manufacture could be established by the indigenous industry of most less developed countries, provided specifications and approved prototypes are made available. Requirements of other instruments will have to be met by import for some time. Technical assistance for both purposes is greatly needed either for promoting local measuring instruments industries, or for the development of repair and maintenance facilities.

The third problem is related to the establishment of an adequate legal framework for the national measurement system and for the regulation of weights and measures in commerce and industry. In many developing countries there exists no comprehensive well-defined law which governs such activities, and the control of weights and measures is usually left to some vague articles or items included in the ordinances or regulations relating to fraud and consumer protection.

To help those Arab countries which have not yet developed such comprehensive legal framework, ASMO has, in collaboration with the International Organization for Legal Metrology (OIML), formulated a model ordinance for the establishment and enforcement of a national legal metrology system.

It should be emphasized here that the mere drawing up of regulations and establishment of the machinery for verification of weights, measures, and measuring instruments for daily use in commerce and industry does not solve the problem completely.

The existence of an authority to promulgate technical regulations and organize and supervise their enforcement is a necessity for the efficient and effective administration of a weights and measures program. Some of the regulatory requirements are too technical to be included in the basic ordinance, and in many countries the amendment of an ordinance is lengthy and tedious. Hence, it is usually recommended that the ordinance deal only with the basic principles, leaving the technical requirements and enforcement details to regulations issued by the local authority concerned. Thus, it would be easier to react without delay to changes in measurement technology, marketing patterns and practices, etc.

An elaborate authorized national body for legal metrology would carry such responsibilities, provide leadership in the establishment and maintenance of the national standards and measurement system, supervise quantity determination and quantity presentations in commerce and industry, and provide consumer services and protection from economic frauds. In order to build such an efficient and effective organization, a country needs stationary and mobile laboratory facilities with adequate instrumentation as well as sufficient reliable staff of qualified and well trained personnel. To determine the necessary laboratory facilities, both stationary or mobile, it is important to define first the appropriate activities to be organized or developed in the country, as related to the types of standards to be maintained, the areas of measurement and calibration or verification, the levels of accuracy and the levels of application, etc.

As the realization and maintenance of primary standards is an expensive task and presents a problem for most developing countries, the national primary or reference standards should be specified according to the actual needs and available capabilities. They should also be appropriately correlated directly to international standards, or to primary standards maintained in another country or in a regional body serving a group of countries. The possibility of regional cooperation in this direction is now under consideration by ASMO, so as to obtain access to the primary standards, which are available at the National Physical Laboratory for Metrology in Cairo, for calibration of other national primary or reference standards in the region. Thus the expenditure of large amounts of money for obtaining prototypes could be avoided until each of the Arab countries concerned finds it possible to obtain and establish its own prototypes of highest accuracy.

As regards qualified and trained personnel, it can be said that their shortage or inadequacy is a general and crucial problem which hinders the advance of many developing countries. Such problems are aggravated particularly in the field of legal metrology, as it necessitates the recruitment of various levels of qualified and trained personnel in the fields of science, technology and technical administration, as well as a reasonable number of metrologists, field inspectors, technicians, shop foremen and scientific assistants. Comprehensive training as related to metrology usually takes a long time, and needs certain experience and facilities which may not be available in developing countries. Technical assistance, both from experienced metrology centers and international specialized agencies, is much needed so that it would be possible for a developing country to start selection and training of the necessary staff in advance of the expected time for the commencement of its national legal metrology activities.

In conclusion, it is hoped that through discussion and exchange of views this seminar will help in formulating a positive procedure to solve the problems which have been touched upon or omitted from this paper. Needless to say, it would be for the benefit of all concerned if the advanced experience of more developed countries would find an easy way to the developing countries. This would help greatly in narrowing the existing scientific and technological gap and in accelerating the rate of world economic growth for the benefit and welfare of all mankind.

Paper 7.4 - The Value of Engineering Standards in Assisting Industrialization in a Less-Developed Country

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My assignment this morning is to share with you a few thoughts on the value of engineering standards in assisting industrialization in a less-developed country. As director of engineering standards for a large metals producer, and president of the organization that serves as this nation's largest producer of nationally recognized standards, I suppose I run the danger of overestimating the value of standards to our society. But it seems to me that no modern industrial society can exist without them.

If standards are necessary to sustain the good health of an already industrialized country, they are equally indispensable in any program to industrialize a less-developed country. And the list of benefits is the same in both cases. There is one benefit in particular, however, of which I should like to speak at more length later, that may be especially significant in any effort to achieve what is commonly referred to as technology transfer.

First, by "standard" I mean any broadly accepted rule of behavior. A standard tells us how to engage in a certain activity. When applied to the characteristics of materials and products of industry, the word standard often becomes an adjective. That is to say, we speak of standard definitions of terms, standard test methods for measuring physical or performance characteristics, and standard specifications for stipulating the characteristics of a material or product to be bought or sold. The activity that is standardized in each of these three examples is that of talking about the product, of measuring its characteristics, and of specifying the characteristics we desire.

I suppose it is possible to envision a society in which commerce takes place without the benefit of standards. In such a society, it would be necessary for the buyer and seller in every commercial transaction to sit down together and, through negotiation, reach a mutually agreed description of the product that is to change hands. To form the basis of the transaction, they would define together the terms to be used in describing the product, the methods to be used in measuring its characteristics, and the set of requirements to be satisfied by the product. Such a society would have as much chance of becoming industrialized, in the modern sense, as each of us would have of owning a modern automobile if we had to make it with our own hands.

Therefore I believe it is no exaggeration to say that, just as human communication would be impossible without standard definitions for the words we use, so would human commerce in materials and products be impossible without standards to measure and define their characteristics. Further, the use of nationally recognized and accepted standards enables us to manufacture, buy, and sell on a scale that we associate with that of a modern industrial state.

Let us list now the commonly accepted benefits of standards, which make them so necessary to the development of modern industry:

(a) Standards enhance communication between buyer and seller.

(b) Standards give the buyer greater confidence in the product.

(c) Standards give the buyer a better understanding of how to use the product.

(d) Standards increase safety in the use of the product.

(e) Standards promote better quality control in the manufacturing process.

(f) By eliminating redundant designs, or grades, standards make it possible for both buyer and seller to reduce inventories.

(g) By enabling the seller to keep standard stocks in inventory, standards result in earlier delivery of an order.

(h) By reducing the need for negotiation, and streamlining inspection and testing procedures, standards provide better performance at a lower price.

(i) Finally, by providing a rational basis for competitive bidding, standards help to reduce prices.

Engineering standards can be prepared in many different ways, and as we look at the standardization systems of the industrialized nations of the world we see a spectrum. At one extreme is a system in which the standards are developed by governmental employees and issued for mandatory use. At the other extreme is a system in which the standards are developed by volunteer groups comprising a balanced representation of all parties at interest, and issued for voluntary use by whoever might wish to take advantage of their benefits. Such standards-developing groups would include representatives from the three primary centers of interest: manufacturers, consumers, and government. Standards issuing from such groups are a compromise among what the manufacturer can economically produce, what the consumer wants and can afford to buy, and what the government feels is in the public interest.

The latter system, which is usually characterized as a "voluntary" or "consensus" system, is the kind that--outside some specialized areas involving public health and safety--now prevails in the United States. It seems to me that the voluntary, consensus system carries with it certain benefits above and beyond those which we have just listed, benefits that can accrue alike to so-called developed, as well as developing nations.

Before I list these additional benefits, let me take a moment to describe in slightly more detail the mechanics of such a system. I shall take as an example, only because I am most familiar with it, Committee B-7 on Light Metals and Alloys of the American Society for Testing and Materials. This committee develops standards for aluminum and magnesium alloys. Its membership totals some 80 or 90 persons, about 40 percent of whom represent producers, such as Kaiser, Alcoa, Reynolds, and so on. Of the other 60 percent, about half are consumers and the other half are so-called "general interests." The consumers include people from the automotive, aerospace, and communications industries, and other industrial users of aluminum and magnesium alloys. The general-interest representatives are from consulting organizations, governmental agencies, and several professional societies.

The point of all this is that the people who are there are knowledgeable. Standards written in a vacuum can be worse than no standards at all. However, when all interests are represented, then you have the greatest chance of writing good, useful, authoritative standards. And by "all interests"

I mean to include not only the technological know-how, but also the economic know-how--the expertise of the marketplace.

I said a moment ago that standardization by the voluntary, consensus procedures provides benefits that are unique to that system. These benefits stem from the fact that all parties at interest are represented on the standards-writing team. These benefits are five in number:

(i) When all voices are heard in the standards forum, the resulting standard is most likely to be unbiased. Objectivity is a very difficult thing to achieve, with even the best of intentions. The theory of the democratic way is that the greatest good for the greatest number grows out of give-and-take among all competing interests. But in this evolution it is imperative that no single interest be permitted to dominate. A balance of interests must be maintained.

(ii) A balanced-interest group is most likely to produce standards that are authoritative. No one can know the problems of the producer quite as well as the producer himself. No one can appreciate the needs of the consumer quite as well as the consumer himself--only the wearer knows where the shoe pinches. And no one can express the public interest quite as well as those who are appointed to guard it. With all these interests present in the committee room where the standard is being written, we have the greatest chance of producing a standard that knows what it is talking about.

(iii) A standard for which all interests feel some responsibility is most likely to be kept up to date. Engineering standards for the materials and products of technology must evolve at the same rate as that technology. Standards are not developed and cast in concrete: once they are born, they must continue to grow and change along with the rest of the world. Unless some group accepts a continuing responsibility to feed the results of advancing technology into the bloodstream of the standard, the world soon passes it by. If that responsible group comprises the people at the forefront of the producing, consuming, and public-interest sectors, then we can rest assured that the signals denoting the need for change are raised at the earliest possible moment.

(iv) A standard written by representatives from all affected segments of society is more likely to be used, rather than to be merely an academic exercise. None of the many benefits of standards that we have listed here at such great length can materialize unless the standards are actually used day-by-day in defining, measuring, and specifying the characteristics of materials and products in the laboratory, on the drawing board, on the assembly line, and on the purchase requisition. And if the laboratory technician, the manufacturing engineer, the designer, and the purchasing agent all had a hand in writing the standards, chances are they will use them.

(v) Finally, the voluntary standards system serves as a great educational institution. I look upon this as being the single most important by-product of the system. To a developing country, this could prove to be as great an asset as the standard itself. The scientist or engineer who works with a standards committee is exposed to a continuing education that he can get nowhere else--neither in the classroom nor on his job.

Transfer of technology from one nation to a less-developed nation must entail a great deal more than the simple shipment of a manufacturing plant across a border. What must be transferred is knowledge, skills--even, if you will, a cast of mind that approaches problems in a certain way. And the transfer cannot take root and flourish unless there can be developed, in the recipient country, what I might call--to borrow a term from governmentese--a technological infrastructure. By that I mean a widely disseminated number of people with the knowledge, skills, and cast of mind that alone can provide the proper conditions for a successful transfer. Transfer of technology must take place from one human mind to another. The day-to-day operations of voluntary standards system is an excellent catalyst for such a transfer.

The idea of the voluntary standards community as an educational institution can most easily be understood by looking at our nation's foremost example: The American Society for Testing and Materials. In ASTM are about 20,000 men and women who form the hundred or so technical committees in which the actual standards development takes place. I doubt that any day goes by on which some ASTM activity could not be observed. To borrow from another source, I might say that the sun never sets on ASTM standards work. Committee members are making literature searches, organizing interlaboratory research projects, meeting to discuss results, drafting specifications and test methods, corresponding with one another, and so on.

Since all this work is pointed toward a standard that embodies the best that technology can produce at the moment, the ASTM committee includes men who are the leaders in their fields, who are working at the frontiers of their areas of technology. A young engineer joining such a committee enjoys the opportunity to work alongside these men on problems that are industry-wide and that demand no less than the best that can be brought to bear. Through his association with these leaders, the young engineer is able to broaden his outlook beyond the boundaries of what he sees in his own organization. In committee meetings he exchanges ideas with his counterparts in competitive organizations. If he is a manufacturer, he discusses mutual problems with men and women who represent his customers. His education is the most effective that can be conceived: elbow-to-elbow and eyeball-to-eyeball.

Nor is his education solely technical. If he is willing to take on increasing responsibilities for organizing and administering the work of the committee, the young engineer acquires the skills of give-and-take and the qualities of leadership that are no less important to the success of standards development than are the purely technical attributes.

To summarize: it seems to me that the value of engineering standards in assisting industrialization in a less-developed country is realized in at least two general ways. First, the standards themselves are an indispensable ingredient for a rational marketplace--without them, commerce would be chaotic. Second, the process of developing the standards, if organized in such a way as to broadly involve the industrial and governmental communities, can at the same time help to develop the human capacities upon which any successful industrialized society must be based.

Paper 7.5 - The Colombia Government Faces the Problem of Quality Control*

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It is not in vain that the press and authoritative spokesmen for industry, for commerce, and for the consumer, as well as various bodies connected with the Colombia Government, have been expressing in increasingly vigorous terms their concern over the quality of our products and that of many imported ones also, and over what this means to our economic development. Not long ago the distinguished president of the National Federation of Merchants called attention to the difficulty encountered by merchants in facing the reactions of local buyers. He also pointed out in urgent terms the risk to which we are subjecting our sellers of exports, all because of the poor quality of our products. Responsible commentators in the press have echoed over and over again this same concern, and they have singled out the responsibility of the government in this matter as if the solution of the problem depended on the imposition of an official system of strict, universal quality control.

Thus a consensus of all sectors has been arrived at, demanding that the problem of the quality of our products be solved by the government. If indeed it is true that the government has an inherent and non-delegatable responsibility to intervene in the matter of quality control, the scope of such intervention still needs to be scrutinized at more length. We must ask ourselves, in the first place, if the adoption of an official control policy alone would suffice to bring about a solution, either short or long-term. What would be the result of a stringent government action to withdraw from production and consumption certain specified articles whose quality was found not to be in complete conformity with established norms? What would happen in practice if such controls were imposed without first providing for the production sector to adjust its procedures, its quality standards, its own internal control systems and the capabilities of its personnel to hypothetical high levels that the government might demand?

Beyond doubt the mere asking of these questions implies the necessity of recognizing that this business of quality is a field in which neither government action alone nor private initiative by itself can accomplish what the common good requires. On the contrary, it constitutes one of the most appropriate territories in which to try out a permanent system of collaboration between the government, the production sector, and the university, as befits one of our great national objectives.

In such a system of collaboration, the participation of the government would naturally have to be permanent, directed on the one hand toward the protection of the local consumer, especially in regard to everything touching his life, health, and personal well-being, and on the other hand toward protecting the reputation of the country in international markets. In this latter area, the efforts we have made, especially in the last few years, have often been jeopardized by the action of one single manufacturer, since in the international sphere the same unjust generalization occurs which we noted in the domestic market. Many times the mistakes of a single member of the production complex have served to characterize the whole.

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*A talk before a Seminar on the National Program for the Advancement and Implementation of Quality Control, Bogotá, October, 1970.

The intervention of the government, although permanent, would have to be conceived of as in a complementary and supplementary relationship to private enterprise. It is first and foremost incumbent upon our entrepreneurs to make a firm decision to acknowledge and assume the responsibility which their position as suppliers of goods and services places upon them in relation to the consumer, who, in the very act of buying, places his trust in them. This applies also to the foreign buyer, except that in his case the good standing and the prosperity of the whole country are at stake. Without this assumption of conscience on the part of producers, the efforts of the government and the control policies which will ultimately be established, no matter how well-worked-out and advanced they may be, will be lost, and instead of contributing to our economic development they will represent only a tremendous waste.

It is well that the state should take an active and dynamic part in the solution of the problem. Using all the facilities and tools at its disposal, it should take the initiative, and once its systems are set up it should maintain its supervisory bodies in a way to make them constantly more thorough and fool-proof. Nevertheless, without an accord with the private sector, all governmental efforts will fall into a vacuum, much more so if the production sectors do not decide to take on their share of the job. They cannot continue to be oriented simply toward the goal of immediate gain.

These seminars which we have initiated in the city of Bogotá, and which in the near future we shall extend to the four most industrialized cities of the country, and later on to others, are specifically aimed at creating in the production sectors the consciousness of responsibility of which we have been speaking. We hope that the result will be an understanding between government and producer so that each will contribute a share toward an adequate answer to the question of whether or not our nation will be able to participate in the necessary competition for international markets, and whether, in the face of the existence of the integration agreement, our products and services will be able to compete in quantity, quality, and price with international products, even within our own territory. It is our belief that this sort of agreement would be the best response of the private sector to the efforts of the government, which, without losing sight of its function of supervision and control, has been willing to move out into the area of complementing and supplementing, in an experiment which fits in very well with a style of permanent dialogue and open doors.

In a national crusade of this sort we have sought and obtained a broad and effective collaboration among various government agencies, such as the Export Promotion Fund, the Interamerican Center of Export Promotion, and the National Apprenticeship Service. Also collaborating are foreign governments, the Colombian Institute of Technical Standards (a pioneer in Colombia in everything pertaining to the problem of quality) and the university, in whose province lies the creating of specialists and the general guidance which every future director of any enterprise must receive.

Directing ourselves specifically now to the role the government should play, we will say that it should be concerned with three fundamental aspects, namely, that of legislation, that of the official control of quality, and finally that of promotion and assistance. Beginning with the year 1959, when Law 155 authorized the government to supervise the quality of products, various decrees have established rules for this supervision, some of them mutually contradictory, with no continuity among the schemes, much less any definite orientation with respect to the extent of the supervision or the means of exercising it. The very existence of various legal measures, invalidated or partially altered one by another, makes it urgent to draw up a statute that will serve in a permanent manner for the government and for private institutions, to direct and define their respective responsibilities in the field of technical standardization and in that of control and certification of quality. A statute of this nature should, to our way of thinking, begin by defining the system under which we must carry on in the future. Should our technical standards originate exclusively with the government, based on adapting international norms to our country, and taking into account simply the points of view of the government itself, the international objectives of the country, or our own internal needs? The alternative is for the private sector to keep on playing a vital role in the process. Consequently, any standards projected should then find their origin in accords between producers and consumers in a process whose culmination would be their adoption by the government as official standards.

Perhaps the first of these two suggested plans may offer attractions to a country like ours faced with a whole series of phenomena typical of a less developed nation. We could count on greater rapidity in the process of adoption of the standards, a feature which would certainly be useful in adopting a means of control with the necessary expediency. At the same time we would be giving the government great initiative in proceeding either with regard to national interest alone, internally, or with regard to export markets--all of which presupposes complete autonomy, a thing of great importance when it is a matter of coordinating so vital an aspect of economic life into the whole complex of the public interest. Nevertheless, this good solution to the problem might not be so good after all if the production sector, being as it is a preponderant factor, should withdraw from participating in the process. Without public discussion of the norms, without previous understanding between producers and consumers, the standards adopted would certainly run the risk of being maladapted to our own economic reality.

Of course, we cannot forget that in the face of growing international competition, in which technical quality and condition play a decisive part, technical standards must constitute a stimulus, a sort of challenge and goal for our production, without becoming, on the other hand, a form of asphyxia for an industry that is still in its infancy. Certainly, then, we shall have to inaugurate a formula of our own, one which considers our special and peculiar circumstances. It must permit us adequate freedom of action, both in the procedure of adopting standards and in the actual practice of quality control. It must enable the state in every case to count on the private participation and counsel most appropriate to the interests of the nation, at the same time assuring that the government can preserve the autonomy and independence of judgment which naturally belong to it, both to intervene, in any conflict of interest, in behalf of the common good, and in any case to decide independently. Finally, it will be necessary for the government to have sufficient powers to take the initiative which our present stage of development requires, an initiative to be exercised in two areas: that of deciding on periodic programs of standardization, and that of adopting temporary emergency norms.

Programs of standardization, then, should respond to the entire complex of plans for the development of the country. They should present an answer to the problems we see springing up in respect to production for home consumption and for foreign markets alike. They should, furthermore, observe an order of priorities so as to protect first of all the interests that touch the lives of individuals most closely--their health and safety--and in the second place the interests that relate to the objectives of the country as a whole--its security, its international image, the strength of its economy, etc. Lastly, they should concern themselves with the interests of the private economy.

If these conditions respecting the government are duly assured, namely, its autonomy and independence, its initiative in planning programs and adopting emergency norms, and its power to make final decisions, nothing would be more appropriate than to provide by law that the process of working out technical standards, insofar as it concerns feeling out public opinion, promoting accords between producers and consumers and studying international standards, be entrusted to a private organization. Nothing can be of more assistance to the government than an organization which, by reason of being representative of all the sectors of production, of agriculture and of industry, can make sure that accords with the consumer are comprehensive and universal enough that the government, when adopting a norm, can have a sure basis upon which to evaluate its social and economic implications. Such an organization can assure at the same time, through use of the most adequate and effective media for public information, that the projects under study will be well known to consumers, with the result that their interests will be duly considered and guarded. This body would have an efficient internal organization, as regards the number and qualifications of its personnel, so that standards will be formulated under an exacting technique, guided mainly by the criterion of advantage to the nation, and with the speed and expediency consistent with bringing the personnel up to date in a field in which we are undeniably behind competing countries in experience and technical knowledge.

Assuming the conditions we have stated on the part of the government and those we have just suggested for the organizations which will function for the private sector, it would be well worth while to undertake a stepped-up and result-getting team effort to effect and bring to completion the process of adopting standards, with a final conference in which the government bodies concerned with each project would take part, so that, in case a projected standard were officially adopted it would be assured of the acceptance necessary to guarantee its enforcement by the government itself and by its subsidiary agencies.

Let this be the moment to render due credit to the Colombian Institute of Technical Standards, a body representative of the private sector of our country. The CITS has been serving the government honestly and efficiently as an advisory body in matters related to technical standardization since 1964. Certainly when we were listing the conditions that the private sector ought to fulfill, we were giving tacit recognition to some that this organization is already fulfilling, and we were also indicating goals whose attainment would not be far away if various sectors of production would decide to offer it better and more determined support.

At the beginning we suggested a second field of action for the government, that of control, and in the case of some products, the official certification, of quality. We do not believe it necessary to give arguments here for the intervention of the government in this area. The interests which find themselves affected by poor or careless quality in our products are so numerous and varied that this matter is, as we pointed out before, one of the few on which a sort of consensus has been reached in this country. Our international good name, our future economy, and even in some cases our lives and personal safety are seen to be jeopardized. One of the officials of the Fondo de Promocion de Exportacione (PROEXPO) told us a short time ago that on a recent foreign tour, three out of every four of Colombia's customers had complained to him about the quality of our goods. And we could go on interminably calling to mind the string of instances that are coming out in the press and in our daily contacts that support and justify a determined and effectual governmental intervention. Nevertheless, it would be unfair if we were to resort to generalizations to condemn in a wholesale manner the quality of all our products, or to explain the entire problem on the basis of a single case. However, it would be illusory to suppose that government action alone, the establishment of control by policing, could automatically solve the problem.

Dr. Rodolfo Martinez Tono, director of the Servicio Nacional de Aprendizaje (SENA), pointed out to us not long ago the necessity of duly distinguishing between two situations: that of the long established manufacturer who, although capable of making products of acceptable quality, is negligent about it because he is concerned only with immediate gain and is not infrequently protected from international competition or by a lack of domestic competition; and that of the manufacturer who, because of lack of technical means and know-how, is unable to produce goods of adequate or uniform quality. Certainly these two situations require two different approaches of the government. In the first case, quality control must take on more the nature of a policing tactic and be directed toward the protection of the consumer. In the second case the state would have to direct its efforts more toward aid and assistance.

In every case, the final aim of the government must be to foment in Colombian management the firm acceptance of the idea of the responsibility which rests upon them, in their capacity as producers, toward the country and toward the local consumer, so that official quality control will be more a matter of bolstering the capability of the manufacturer to control his own production effectively than of controlling the products themselves. In the same way, in the case of those products for which various factors make it advisable, we ought to talk about an official certification of quality and not of an official guarantee. In this way, the manufacturers retain all the responsibility toward the consumer that is rightfully his, and the consumer will make his claims against the manufacturer himself and not against the government.

We have touched very briefly and superficially on some of the implications that arise upon considering a possible governmental position on the problems of technical standardization and the control and certification of quality. It has also been our wish, above all else, to lay before you a pattern of projects rather than a list of accomplishments. The carrying out of these projects will undoubtedly require that the government upgrade some of its organizations and acquire the technical means to enable them not only to reach a greater capacity in reviewing and deciding but also to improve the qualifications of the responsible officials in the different aspects of technical standardization and quality control. It will be surely necessary to call on the technical assistance and experience of nations with a longer tradition than ours. We are already working on this. Our deepest wishes are that this dialogue which we have opened today with such a distinguished group of representatives of the private sector may continue and that from it we may realize marvelous results for the good of our country.

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Paper 7.6 - Quality Control and Product Certification

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As everyone knows, standards and specifications are the tools with which a product or process is examined so as to permit it to be classified as "good" or "bad." This judgment must be based on specifications or quality standards rather than on a subjective opinion. As the inspection process can vary from one manufacturer to another, or from one state to another, it is necessary to establish a common rule, a sampling standard, concerning the number of pieces in a given lot which are to be examined and how many defective pieces can be tolerated. In the same way and for the same reasons the test methods must be standardized too.

When these standards: quality, sampling, and test methods are established it is easier, at least in theory, to carry on a quality control program and to be certain that the results obtained can be fairly compared. After an effective quality control program is established and the products are tested regularly for compliance by selected laboratories, a National Institute of Standards will be able to certify that the product complies with such standards, provided that the testing process used by the selected laboratories has been found to be uniform and valid. This certification from the institute which can be indicated by the use of an institute mark is a warrant that will serve to assure the consumer that the product he is buying will meet his needs and will serve the producer by telling his customers that his product is good.

This certification mark will help to introduce a product in the national market and it is essential for selling the product in the international market. If the quality standards are set too low or if the facilities of the standards institute are not adequate to assure the quality of the product, then the product cannot be introduced into other countries. Even if a manufacturer succeeds in selling an inferior product once, the country's market for that product may be lost forever, and other products may suffer because the reputation of the standards institute has been lost. That is why the standards institute must make the necessary provisions to be absolutely certain that the mark will warrant a competitive product not only in the domestic market but with much more reason in the international one.

Many less developed countries lack laboratories and test facilities, and that must be remedied before a certification mark program can be launched. In almost all Latin American countries, including Peru, it is necessary to establish first of all a metrology laboratory as a basis for standards and for all the other laboratories. Latin American countries are trying after a number of years, to establish a common market that will permit an industrialization compatible with the capabilities of each country. That is why the Pan American Standards Commission (COPANT) has been created. It has already established some 200 recommendations and we are trying to accelerate this process.

There was recently established a common market and industry allocation agreement among five Latin American countries in the so-called Andean Group. It is intended that within the next 10 years, every product of the zone will be commercially available throughout the zone, with no customs barriers. To do this it is necessary for these countries to establish common standards and adopt the use of accepted certification marks. Of these five countries, three already have their own standards institutes and the other two are creating them. In Peru, the Standards Institute began to work in 1961. At this moment there are about 400 recognized standards documents and we are currently working on a similar number.

Since last year, a new law has authorized this institute to develop a certification mark and to do technological industrial research as well as standards work. This same law provides that each firm must use at least 2% of its income for scientific and technological research. If industry does not use itself or through private or universities laboratories, this 2% must go to the institute to improve its facilities and to permit it to do the research according to carefully selected priorities.

These new factors have resulted in a revised idea of what our Standards Institute should do. As a consequence, it has been necessary first to reorganize the institute and second, to look for foreign assistance in the form of experts, training facilities and equipment, as well as financial support, so as to improve the existing laboratories and to establish new capabilities.

SESSION 7 - PROMOTING ECONOMIC STRENGTH AND COMMERCIAL EQUITY

Discussion

Co-chairmen: Inyong Ham and Henry A. Arnold

Mr. Woodington:

I would appreciate comment from any one or all of the speakers this morning on their opinion of the value of quality control as related to the national standards institutes.

Dr. LaQue:

A mechanism for quality control would be absolutely essential to anyone presuming regularly to produce something in conformance with a standard. Quality control becomes particularly necessary when standardization is supplemented by certification of compliance. To be able to certify compliance, particularly of items produced in large quantities, there must be a highly organized system of sampling and quality control. This assures that, on the average at least, all the products that are supposed to meet the standard will in fact do so. The importance of quality control is underlined by the special meeting of the European Organization on Quality Control (EOQC) to be held in Moscow in June, sponsored by the USSR Ministry of Standardization.

Dr. Salama:

When the Egyptian Organization for Standardization started standardization work we believed that quality control must go parallel with standardization. Therefore, in the structure of the Organization itself there was a department for quality control, and its work has developed the quality mark. There are courses available for training in in-plant quality control, so as to insure that in all the steps of production specifications are applied. The Egyptian Organization for Standardization also adhered to the membership of the EOQC so as to obtain experience and information and seminar training. Then when we expanded this sub-regional organization to other states by creating ASMO, it was agreed that quality control should be an important element. That is why ASMO adhered as an institutional member to EOQC, participating in all its activities and conferences. Last month we held a seminar and the EOQC secretary gave a very useful paper about the inter-relation between standardization and quality control in less developed countries. He also described the stages that keep these activities parallel with each other.

Dr. Ghosh:

As Dr. Salama has said, quality control and standardization go hand in hand, and in India we also work with certification marking. When we agree to allow certification marking by an agency, we see to it that he has the quality control system ingrained in his production line.

Mr. Felleke:

The Ethiopian Standards Institution is in the process of developing a standards mark, and I fear that in order to implement the certification we shall probably need an army of officials for inspection. Will Dr. Ghosh please discuss their experiences in this situation?

Dr. Ghosh:

First of all, to dispel your fears, sir; we do not believe in having a police force stationed at the licensees' office to control his work. We believe in trusting the quality control done by the manufacturer himself, but we have a small staff to do a "technical audit", just as a company would have its books examined occasionally by an independent auditor. Certification marking is voluntary, but the ISI Certification Marks Act is an Act of Parliament, which means that if you volunteer to be a licensee for that year you are under the provisions of that Act. If you misbehave, there are penalties under the Act but after year-end you could equally voluntarily withdraw from the scheme.

To enforce this Act, there must first be an Indian standard. However, we have found that many of these are inadequate because evaluation procedures were defective or necessary equipment was lacking. Therefore we are re-examining them all. Recently, we found a manufacturer who wanted a certification mark on a product for which we have not produced an Indian standard, but there was a British standard. So we have taken the modus operandi of immediately recognizing such a standard by giving it an IS number and immediately giving the certification marking on that number. Of course, we see to it that the company is able to produce continuously, and to check continuously against this standard. Simultaneously, I ask the standards-writing committee to decide within six months whether this standard could be adopted, adapted, or amended, so that the licensee can then be guided by a real Indian standard. We have issued more than 2000 licenses for certification marking. The entire production in organized sectors like cables and conductors, steel, and so on are completely covered by certification markings. There is no question of enforcement, but the law is there and the licensing is under the law. There is a small certification marking fee.

Mr. Wilson:

I would warn about taking too much for granted in the application of standards and test procedures once they are given to a less developed country. I was assigned to a country to set up a testing laboratory for soils, materials, and hydraulics and I made a survey of field projects. I went to a concrete barrage type dam under construction and asked to see the quality control records on the concrete. The engineer showed me a beautiful ledger covering the testing for the amount of material that had been placed and it seemed a very commendable control record. Then we went on a tour of the facility. Outside the laboratory were two auxiliary buildings which were built out of unbroken concrete cubes. They said, those are the test cubes for the concrete control. It turned out that there never had been a testing machine on the site. They had determined their breaking strengths from a theoretical curve based on the density of the material. So they had excellent quality control by the ledger, but virtually none in practice. I think that this type of problem arises all too frequently; if we do not supervise down to the lowest technical levels.

Mr. Tam:

I would like to ask Dr. LaQue whether the International Organization for Standardization encourages less developed countries to participate in the work of ISO. If so, what are the criteria for this participation? I ask this question because we did send in a letter to ask for information, and later an application, and we did put aside some budget for that participation. The Government of Vietnam has become very impatient in the last three years, because we have never received an answer from ISO.

Dr. LaQue:

I must first say that I have been President of ISO for only about a month, and obviously I have inherited some problems, but you have registered your complaint and I will look into it as soon as I possibly can.

To answer more broadly the general question you have raised, there always have been handicaps of distance, since committee members generally come from Western Europe. This is a situation we hope eventually to correct by distributing the meetings more widely geographically. However, even when you may not be able to participate directly in committee meetings, there is provision for corresponding memberships, but which you are kept informed, and can register your views by correspondence.

Dr. Ghosh:

It is necessary for the Secretary General of ISO to find out whether the Vietnam Standards Organization is the national body for standardization. In several countries there is more than one body and that raises a little difficulty.

Mrs. LeRoux:

I want to give you an example of one of the many problems encountered in technology transfer and standardization in less developed countries. We have in the Peruvian Institute about 60 committees and almost half of them have problems like this one. The committee on electrical cables is now trying to write standards on cables for the automobile industry. We have in Peru five automobile manufacturers, one is British, the others are from the USA, Germany, and Japan. We have three electrical cable manufacturers, one European, one from the USA, and one Peruvian. Here are different technologies, all with different specifications, using different metals. Which one can we use? Trying to prepare national standards in a less developed country has the same problems as preparing international standards. I do not know if someone can give a solution for this kind of problem.

Dr. Ghosh:

The best solution that I can suggest is to follow the IEC standard for cables and conductors. Britain, the USA, and Japan have all contributed in preparing these standards. You can certainly expect them to be adhered to.

Mrs. LeRoux:

This was only one example. There are many other problems like the one I quoted due to technology transfer from quite different sources.

Dr. Ghosh:

If we have these problems spelled out to us we shall certainly try to give you our experience if that is of any help to you.

Dr. Rohatgi:

I have three quick questions for Mr. Smith: What is the source of finances for the ASTM? What is the annual budget? How is the consumer represented in ASTM committees?

Mr. Smith:

For industrial type standards, we have industrial consumers in mind. When you are talking about the ultimate consumer, there is a problem which we have not yet solved. The annual budget of ASTM is about four million dollars. Revenue is obtained from sustaining memberships of industrial concerns, government agencies, and so forth, at $200 a year. A high percentage of our participants are individuals paying $25 per year. The greater part of our income and our expenses come from the sale of the books of standards and other publications. A membership entitles you to a discount effectively equal to the cost of the membership.

Mr. Lartey:

The experience of the Ghana Standards Institution may be useful to Mr. Felleke on the question of how to operate a certification mark scheme effectively. Rather than setting up an army of inspectors, we have found that we can quietly use the consumer to insure success. We have sponsored a Ghana Consumer Association which is rapidly becoming a very powerful organization.

Dr. Astin:

Let me take issue with Dr. LaQue on one small point in his very excellent paper, where he used the budget of ANSI as an index of financial investment within the USA for standards development activities. That is just the tip of the iceberg. Virtually all of the individuals who work on the ANSI, ASTM, and other committees involved in the development of standards have their salaries and travel expenses paid by their supporting organizations. As a matter of fact, NBS alone invests more in supporting standards development activities in the private organizations than the total ANSI budget. I would venture to say that the total USA investment for the development of standards is maybe 50 times the ANSI budget.

Dr. LaQue:

I must say that I agree completely with Dr. Astin.

The possible use of standards as a basis for certification or quality control must be kept in mind when standards are written. ISO has instructed its staff in preparing new guidelines for the development of international standards to include a warning that they are likely to be used for certification and quality control.

In response to the question raised by Mrs. LeRoux, I have made a rough plot of the production of ISO standards from 1951 until 1969. If I have drawn it correctly it should reflect the fact that as many international Recommendations were developed in the last 2 years as in the whole preceding history of ISO. We have now reached a saturation level, and the procedures currently used cannot produce standards at any higher rate. Since there are as many as 20,000 national standards in use in some countries, and only 2,000 international Recommendations in existence, it seems quite evident that we cannot go on at the present rate to deal with the world's needs for the next 10 or 15 years. A change in mechanism and procedures seems to be imperative. It is also imperative that priorities in the ISO work must be established. If the less developed countries want to be sure that the priorities reflect their needs, they have to become involved directly.

Prof. Ham:

The Chair would like to recognize Dr. Work and Dr. Ghosh. Would you please confine your comments to the budget questions that Dr. LaQue raised.

Dr. Work:

In Iran only about 22% of the work of the testing laboratory of ISIRI is directly associated with standards. There is industrial research, weights and measures activities, the hall-marking of precious metals, the training activities, and the certifying of exports. ISIRI also operates a scheme for the insurance of exports; there is a tax of half of one percent on all exports. If a damage claim is sustained ISIRI must pay it. Then they have the quality control work, although the quality control itself is done in the factories, and of course metrology is part of the total operation.

Dr. Ghosh:

The latest figure for the Indian Standards Institution is about 12 million rupees. It would be about one and one-half million dollars. The government contribution is only 5 million out of the 12 million rupees.

Mr. Felleke:

National standardization is relevant because of social and economic implications, and in a shrinking world, international standardization has also its place; but does not the direct link between them obscure the task for regional standardization?

Dr. LaQue:

Particularly for less developed countries, regional bodies do have a place and a function, because at the rate at which international standards are being developed we cannot expect that the special needs of different regions will be dealt with on a timely basis. As for developed countries, a European organization called CEN, a group of the European free trade area and the common market countries, have not been able to wait for ISO to provide what they need. The regional bodies have gone ahead and made some regional agreements in advance of international ones.

Dr. Ghosh:

Of course there is a need for regional standardization, but may I sound a warning also. I had a rather bad experience with the European committee at one of the IEC meetings in Israel, when in advance of the meeting someone got up and said, Next month we are going to have a meeting of the Economic Commission for Europe Standards Division, and we are going to agree on certain principles. The IEC committee may be very well advised to adopt this, or else.... So I have to say that certainly if good technical work is done elsewhere there should be no objection to adopting it. However, too much regionalization may cause retardation because preconceived opinion would have a harmful effect on the ultimate evolution of international understanding.

Dr. Salama:

From my experience on the joint commission between WHO and FAO for food standards, I note that they have organized separate regional committees for Africa, Europe, and Asia. The nature and markets of some foods are such that regional standardization is almost a necessity.

Mrs. LeRoux:

For less developed countries on this side of the world it is difficult to attend meetings of ISO, that are always in Europe. Besides, in Peru 20% of our budget is to pay ISO dues. After that we have to pay dues to the Andean Group and to assist the FAO. After that we have little money for work at home.

Dr. LaQue:

I assure you that this has been bothering me as well. We have instituted a study of the whole rate structure of ISO, hoping that we can introduce a better distribution of the burden between the highly developed and the less developed countries.

Paper 8.1 - A Systems Approach to a Conference Synthesis

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In attempting to use the techniques of operations research in achieving a conference synthesis, I have provided a six-page handout that I would like to pace through with you. The tone of the conversation will change rather markedly as we try to summarize what I think the members of this workshop have been saying in the previous seven sessions. The purpose of my paper is to try to tie these assertions together in some kind of logical pattern and to drive toward a conclusion. The paper could not be written before your deliberations took place and therefore could not have had the benefit of prior review. Any defects in its inherent logic should be laid to me for not hearing right, or to you for not saying it right, or to both of us.

For the handout I have used the following outline:

I. Seminar Purposes:

A. what is the role of standards in an industrializing economy?

B. what are the detailed requirements?

- types of standards needed
- levels--minimum or more
- organization of infrastructure
- resources of time, money, facilities, people

C. recommendations for a future NBS program

II. The logic of analysis

A. general process diagram

B. parties at interest

C. facts

D. criteria

E. alternatives

F. an alternatives/criteria matrix

In Section I,I have listed what I understand to be the threefold purpose of this seminar. Next I shall try to take the material that you have so eloquently delivered and put it together by the logic of Section II. I have traced the logic for you so that you can tell me if I have reached erroneous conclusions.

Under IIA, I call your attention to the fact that we wish to be bold and say: There is a standards system; there is an industrializing system. We play bridge 13 plays ahead. We play life 4 plays ahead, but we sometimes play the management of our affairs only one play ahead. I hear a lot of one-play links being discussed here with some estimates as to what the next play might involve. Let us put all these links together and see what happens if they fit.

IIB - I assume that we are having a workshop to solve a problem, and that there is a problem because there are parties at interest who have conflicting purposes. Otherwise the problem would be simply that of overcoming nature. So I would like to draw attention then to what I believe you have either said or implied their conflicting objectives are.

IIC - You have provided me with many facts which I have sought to take into account.

IID - I have tried to list explicitly the criteria by which a choice as to recommendations might be made. If we aim to give standards a role in the industrializing process then surely what we should do will have to come out on the basis of those criteria.

IIE - Making recommendations for a future NBS program implies that we get some choices to select from, and those possible choices I am going to call alternatives.

IIF - Finally, I will compare those alternatives with the criteria in what I have called an alternative-criterion matrix, copying from an inspired notion that Dr. Huntoon applied to one of the early stages of the metric study.

Now, if you will turn to Figure 1 you will see a very, very simplified flow chart. Do not read it from left to right; read it from right to left.

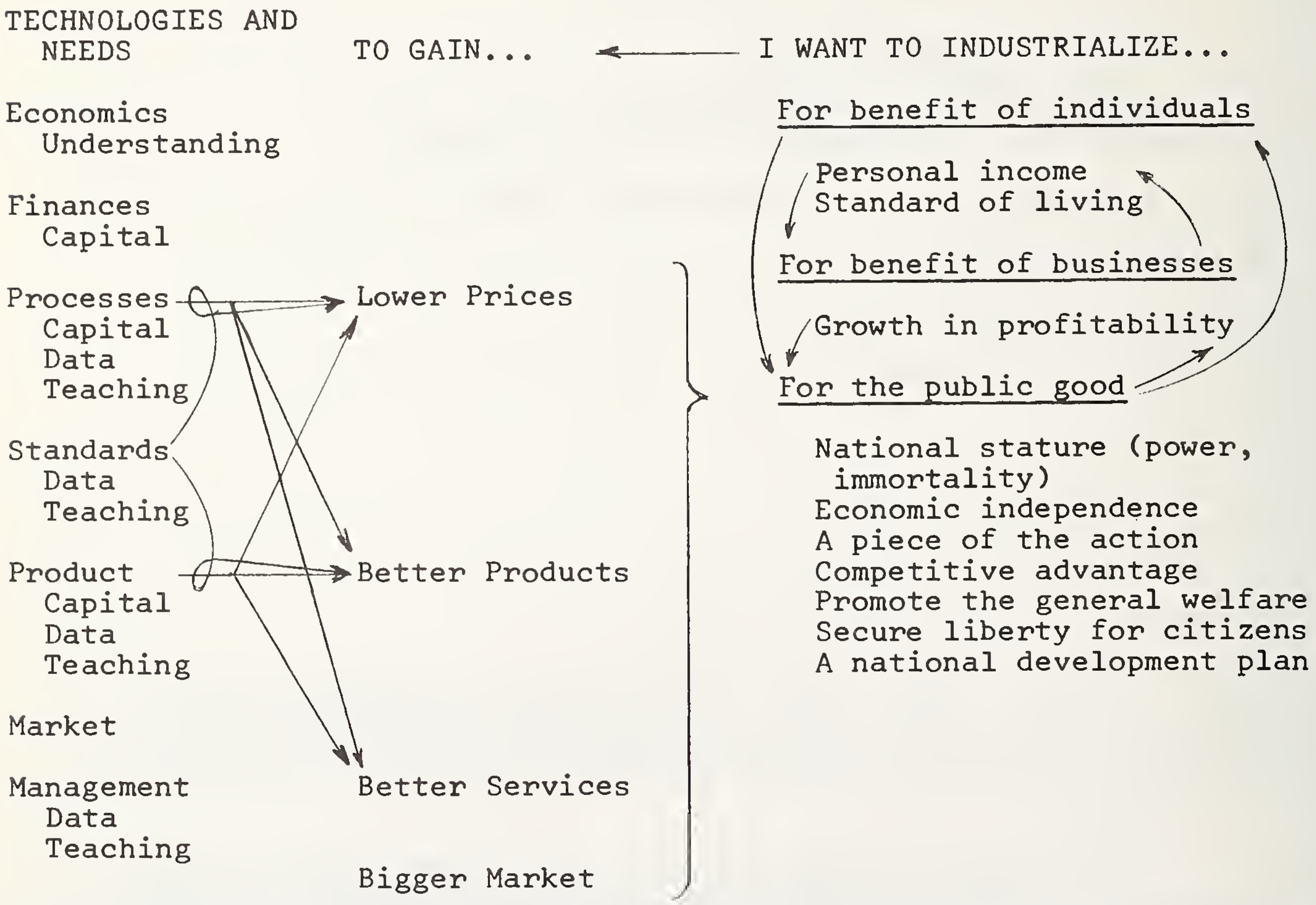

Figure 1 - The attitude of any developing country at varying stages of evolution--with different patterns of distribution, with varying goals and attitudes.

The flow chart says: I, a developing nation, want to industrialize. I want to industrialize to serve three types of parties at interest. I have put the benefit of the individual, the customer, the citizen, at the top of the list as being the ultimate base of power for decision. I hear us saying we want to improve per capita personal income, as well as the individual standard of living. Also in this country we have created a legal person called a business or a corporation, and this has many of the attributes of a natural person. I hear it being said here that so far as the newly developing nation is concerned those businesses would like to enhance their profitability by enlarging their share of the market. Lastly, we have a public institution, really many, because in the U.S.A. there are 80,000 units of administration because we have a decentralized form of government. These institutions of government, in our nation as well as in yours, operate on behalf of the public good. I now try to project myself into the personality of a newly developing country. For that country I want national stature; this means power, and in a very real sense, immortality. I do not wish to lose my sovereignty, I do not wish my bureaucracy to disappear, I wish to have economic independence. I wish, thank you very kindly, to have a piece of the action, as you say in the U.S.A. these days. I wish to have competitive advantage on a world market, I wish to promote the general welfare of my people, I wish to secure liberty for my citizens, and I have a national development plan. Now that is why I want to industrialize. If I am to see benefit in the industrialization process, it will be because it contributes variously to these goals. If I ask what should I do in standards in order to assist the industrializing process, I look for the answer in the marginal contribution of having a standards activity contributing to the industrializing process or contributing directly to the satisfaction of these goals. When I can tell what that benefit is, then I can tell what kind of standards role I wish to play in the industrializing process. At the NBS one of our economists has looked at bits and pieces and has concluded that the public investment in developing steel standard reference materials provided a handsome benefit/cost ratio in terms of the public interest, but that is only a piece of the problem. What else got involved in the industrial process that also had to be paid for? What could have been done instead of that? This is the kind of logic that is not yet complete.

In the next column to the left, I hear you saying that the purpose of industrializing is to produce lower prices, better products, better services, and a bigger market. Moving again to the left, we find many technologies involved. We have concentrated this week on the standards technology, the process technology, and the product technology. I have shown intertwining wiring diagrams to suggest that all of these technologies combine to provide joint inputs that create these other joint outputs on the right. On those isolated occasions when I heard a developing nation identify things that were needed, I wrote it down. That forms the left-hand column. With respect to economics, I heard you saying: I do not understand the nature of economic phenomena. My response to that is: Neither do we. On financial technology, I hear you saying: I need money. On process technology, I hear you saying: I need capital, I would like to have information, and I would like to have you teach. On standards, I hear you saying: I would like to have information and I would like to have you teach. On product technology I hear you saying: I would like to have money, I would like to have information, and I would like to have you teach. I did not hear you say very much about what you would like to have on market technology, but on management technology I hear you saying: I want information and I would like to have you teach. Now this is a grossly simplified chart for a number of reasons. Each nation stands at a different stage of development. I would like to suggest that this may not be an evolutionary chain, but perhaps a cycle. The U.S.A. is beginning to ask the question: What is the public good? So we may be starting at the bottom again on the way up. The chart is simplified because in any nation there are different patterns of distribution, and each nation has its own goals and attitudes. Part of the problem is that there are pockets of high technology activity while other areas have nothing of that sort.

Now, if we list a similar set of needs specific to the U.S.A., it would look something like this:

U. S. Business Needs:

growth in profitability
stability
maintenance of competitive advantage
lower prices
better products
better services
bigger markets

U. S. National Needs:

U. S. national interest
political neutrality or favorability of other nations
elimination of threats to peace
vigorous trade
balance of payments
avoid adverse effects of serious proportions on U. S. industries
better standard of living
secure liberty for citizens
achieve national goals
assure equity
assist other nations to realize their goals

I hear you all saying that we, too, want growth and profitability. I hear U. S. business saying something which surprises me a bit--that stability is one of the factors. In helping other countries, we want to maintain our own competitive advantage as well, and then we want advantageous prices, products, services and markets just as you do. From the U. S. Government viewpoint, we look out for the country's national interest, and I hear us asking very much the same things on behalf of the public good that you do. We wish not to have other nations to be hostile to us. We do not want to have a world war, we do not want other lesser threats to the peace. We, too, want vigorous trade, but we have got a balance of payment problem, and it is part of the public interest to make sure that the industrial sector of the American free enterprise system is not assassinated in the process. In a sense, there is a public good in protecting against very severe adverse effects on our nation's business. We want to achieve the same things for the citizens that you do. We have a special problem with respect to equity for people who are black and poor both within and outside the U.S.A. We wish to help other nations realize their goals. So in the U.S.A. we, too, have three parties at interest, and we see now that the real dilemma is how to assist developing nations without displacing our own markets. Evidently the problem requires a bigger synthesis than we had before, and this realization will help to focus our discussion.

Now I said that what we want to do is to hunt for a recommended NBS program. For this there are criteria. These criteria come in part from the UNIDO Monograph 20 and since you have seen them before, I merely list them now but we will come back to them:

Criteria (in part from UNIDO Monograph 20, Industrialization of Developing Countries: Problems and Prospects)

raise standard of living
accelerate rate of development (volume, rate of growth, share of GNP)

develop economic independence
use economies of scale
maximize the use of regions
develop in areas of political priority
achieve public/private balance
balance of payments
improved distribution
make financing available
training
raise product quality, value added, capacity utilization

Next we have a page and a half of possible things that the NBS or somebody else ought to do. These are listed in order of their chronological appearance at this seminar, beginning with the ad hoc solutions proposed by Mr. Dennison from VITA (see Appendix 1). I had to stop appending alternatives to this when Dr. Salama finished last night, because the list had to be typed and reproduced, so I have not yet added the inspired summaries that were given by this morning's speakers. Nonetheless this is what I see now as things that have been suggested as what we might do.

Alternatives (in order of appearance)(sometimes standards, sometimes technology, sometimes both)

provide ad hoc solutions (fibreglass boats, village technology)
volunteer efforts
disseminate information
provide management assistance
develop and distribute self-help manuals
survey opportunities
respond to requests
adapt high technology to evolving needs
help set up an infrastructure for the standards process
assist in changing the potential to the actual
develop a planning technology
education technicians, managers, financiers
develop a cadre of available scientists
make international comparison of activities possible
assist in developing regulations
find out what the problems are
develop industry rather than metrology
develop metrology rather than industry
get over the dilemma that if we buy technology, there are resource constraints that limit other need satisfactions
mass produce housing overseas
find labor-intensive technologies
help us eliminate government inefficiency
urge foreign direct investments
stay away from extractive industries; they will be nationalized
find out what is common and unique among LDC's
get some bright scientists to work in standards
stop selling space technology; it can't be used
follow the NBS Weights and Measures procedures
bring the technical people together in national or regional institutes
find multipliers--things that can have multiple uses, not single application ad hoc bits
help small countries band together in regionalized units
make technical people available as rental consultants
set up a mechanism to encourage lateral contributions among LDC's
make experts available for export and import certification councils
find technologies that are suitable for markets an order of magnitude smaller than yours
do not try to compress lead times that are incompressible

make the universities more applied
set up an analog of the land grant college system
procure standards off the shelf rather than develop your own
do a systems analysis of what is needed
teach people how to use equipment
teach people how to procure equipment
get your industries to rent the labor of LDC's
make SRM's for LDC's
make a "World Center for Peace Technology"
develop data systems
set up information networks
set up standards on product safety and product performance that can be used
deliver and show how to use minicomputers
show how to set up communications networks
set up standards for food and agricultural products, road design, traffic regulations and signs, postal and telecommunication systems, railway design and operation, electric power supply systems, seaport design and operation, airport design and operation, banking systems, and foreign trade documents
help us write requirements specifications
help us set up educational TV
speed up the research-applications interface
concentrate on rural development
assess technologies
make forecasts
find technologies that do not displace labor
sell technology as a commodity

Now we have followed the logic, we have listed possible alternatives, and we have set up criteria. Turn to Figure 2, which suggests that while it would be interesting to evaluate each of those simple alternatives by themselves, how marvelous if we could combine them in some way. These package suggestions then are now labeled alternatives and are numbered one through nine. Number one is: Suppose we do not do anything, but leave life as is, or as Dr. Huntoon would say, adopt the non-intervention alternative. So on down through a consulting program, data information networks program, a major concentrated training effort to include going to your place and teaching, having your people come here and learn, developing handbooks, translating literature, and so on. Number five: Before you try solving all these problems, why do not you figure out what the problem is and where the real needs are? We have looked at the total system and I have to comment that this assessment involves spending money and losing time even if the answer might be a bit better than you would have had before. Number six: Concentrate on what has been called in the U.S.A., technology utilization--bring space back to earth. Number seven: Simply act as a godfather to the creation of an intrastructure, an organization, or a set of standards for the less developed countries. Number eight: Why does the NBS not recognize that creating this kind of effect involves contributions from all the partners that we normally work with--ANSI, ISO, IEC, trade associations, other agencies of government? Number nine: Assist in creating the International Development Institute that was mentioned as being one of President Nixon's proposals to the Congress.

So those are package alternatives, although obviously any one of them could be elaborated, subtracted from, or combined in other ways. I next suggest that these alternatives could be assessed against the criteria listed earlier, which are laid across the top of the figure. Would this really raise the standard of living significantly, would this really affect your balance of payments, would it really affect our balance of payments, would it really accomplish training or is it just make-believe, would it really change your competitive advantage or is it likely to be merely a gesture? We have allocated these criteria and objectives to the less developed countries, to industry, and to the Government of the USA, and to the NBS. I observe that the effects would be a function of time, because delay times are different. As Dr. Condon says, we must not try to compress a decade into a microsecond, because it will not squeeze.

We then have the audacity to suggest that we could put symbols into these columns by way of value judgments. A plus means, sure it would help in a big way. A zero means, I do not think this really will have an effect on that criterion. A zero with a plus means, it probably will not help but it might have a positive effect. A minus sign means, that is not good, it works in the opposite direction. I tried to enter some of these as I heard things said on behalf of the less developed nations. A question mark means that is something we should find out. I did not write things down about U.S.A. industry because I do not know much about U.S.A. industry. I did start filling out some columns on behalf of the U.S.A. Government and I did have the temerity to offer some suggestions as to NBS feasibility and compatibility with current policy.

In those last columns you see some dollar signs, a t for time, and a partial derivative sign to indicate a step function. I was guessing there. I think the laissez-faire attitude is not consistent with NBS goals. The differential sign by number four suggests that if we went into a major training program, this would involve some minor modification to the goals, structures, and operations of the NBS the way it is now. For number six, translating highly sophisticated technology to the needs of the less developed countries, should have a great big partial derivative sign, because fitting high technology into a low technology environment is a big problem that nobody has solved yet.

Maybe I have shown some prejudices in filling out this chart, but if we laid it out collectively, we could discuss various points and we could very quickly eliminate those things that nobody really cared about. We could get down to those cells in the matrix that really make a difference to somebody, and we could start working toward the solution of those problems. The kinds of inferences that I see are that because there are so many minuses in everyone's column for number one, the recommendation to let things stand the way they are is not in anybody's interest. The fact that there are so many zeros and question marks on the consulting program leads me to believe that the effectiveness may be slightly positive but that program does not really tackle the major problem. Number four seems to have a strong population of pluses, and my assessment that dollars and time would not be really significant, and that a change in tone at NBS could well accomplish it, lead me to believe that maybe we ought to do that kind of thing. That is what I hear us all saying, that is what we all come back to as involving the least compromise of anyone's goals.

Personally I am still troubled by my flow chart, by the value judgments, and by the prescription as to what it is that really needs to be done. I have not bothered to fill out a lot of the other columns here, partly because I think the inferences are relatively apparent. However, number six, translating the high technology that the less developed countries need, sounds like a pretty good thing to do too. The difficulty is that it is fantastically expensive and we do not quite know how to do it. There were some suggestions yesterday from Mr. Daneman that, in fact, this translation might take place relatively smoothly at the level of an individual country, and he cited some examples.

I will conclude by observing that what we have tried to do was to say that this was a working seminar and we were supposed to get some answers. One of the questions was, what is the role of standards in the industrializing process. The answer I hear consists of a lot of assertions with some case study documentation. We have been behaving as badly as the archeologist

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who digs up pieces of pottery and cannot decide what the civilization looked like, or the political scientist who deals with case histories and is afraid to put measures on the course of a nation. We do not know what the role of standards is in an industrializing economy. We tackle the standards process piecemeal. We have saluted the right flags, but we have not really answered, I think, the question of what, in fact, is the role of a standard in an industrializing economy. We know some of the mechanisms qualitatively, but we do not know the quantitative coefficients. On question B, what do you need, we again have a lot of vague prescriptions. On C, I come to the conclusion that the NBS should assemble a major training program and make this available to the newly developing countries. That may be the best initial contribution toward reaching the goals that we all are trying to realize.

Criteria And Objectives

	Less Developed Countries																		US Industry							US Government												NBS	
Package Alternatives	Raises std. of living	Accelerates rate of dev.	Develops econ. independ.	Uses economies of scale	Maximizes use of reg.	Political priority	Public/private balance	Balance of payments	Distribution	Makes financing avail.	Trains personnel	Raises product quality	Raises national stature	A piece of the action	Competitive advantage	Promotes general welfare	Secures liberty	Econ. development plan	Profitability	Stability	Competitive advantage	Lower prices	Better products	Better services	Bigger markets	Feasibility	US national interest	Political neutrality	Elim. threat to peace	Vigorous trade	Balance of payments	Avoids adverse effects	Better std. of living	Secures liberty	US national goals	Assures equity	Assists other nations	Feasibility	Goal consistency
1. Laissez-faire		0	0 +	–	0	–	0	–	0	–	–	–	–	–	–	–	–	?								+	?	–	?	?	–							+	–
2. Consulting program	0	+	0 +	0	0	?	?	0	?	? –	0	+	?	0 +	?	?	–	?								+		0	0	0 +	0							+	0
3. Data network program	0 +	+	?	0	0 +	?	?	0 +	+	?	0	+	0 +	+	+	0 +	?	+								?		+	?	0 +	0 +							?	+
4. Major training program	+	+	+	0 +	?	?	?	?	+	0 +	+	+	+	+	+	0 +	?	+								+		+	0	?	0							$ t	∂
5. Assess total needs of LDC's	Time lag before effects; subsequent action required																									+	0	0		+	+							$ t	r
6. Translate high technol to LDC needs	+	+	+	0 +							0															+	+	+	?	+	+							?	∂
7. Godfather to LDC infrastructure	0	0 +	+	0 +	?	+		?		–	0 +															+		+		+	0 +							+	+
8. Focus US govt - industry help																										?		+	?	+	+							$	+
9. Help set up IDI																												+										?	+

Figure 2
Matching Some Package Alternatives to Criteria and Objectives

Paper 8.2 - Using National Measurement Standards

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My assignment for this conference boils down to this: listen to the points of view expressed during the conference, devoting particular attention to Session 3 on Making Scientific and Technological Measurement Meaningful; summarize them and point out expressed needs; present a program of actions that NBS might undertake to assist the developing nations in reaching their goals for industrialization. An additional constraint was imposed. The discussion was to be limited to the aspects of assistance related to the use of national measurement standards. Dr. Astin unexpectedly covered the entire subject with his informal comment that it is unnecessary and perhaps even ridiculous for the developing nations to undertake the duplication of prototype standards for the SI system. He pointed out that prototype standards are already being produced and are being improved energetically and at great expense in several of the major national standardizing laboratories. Their work probably represents sufficient effort on that undertaking. Other establishments should apply their limited resources to other more immediate needs. I agree with this point of view. My allotted subject areas therefore approach zero and I am left with nothing appropriate to say. I am prepared to stop now if you wish. On the other hand, you should know that the program committee has helpfully relaxed the constraints. They will allow me to cover all aspects related to physical measurements and standards, leaving engineering standards (norms) to others.

Thus, since there is no outcry for me to desist, I turn attention to the broader subject--what NBS may do in the realm of physical measurements to help the developing nations, based upon what has been said here. However, it seems inappropriate that I should undertake to prescribe a program for NBS action. It seems better to present a plan in the guise of suggestions to NBS which the members of the conference may accept, reject, or modify. The members may then indicate the extent of their concurrence and express to NBS the wishes of the conference. With this understanding, we can proceed.

Unfortunately, Dr. Cushen's excellent synthesis of the needs as he heard them expressed here became available too late for me to give it the careful attention it truly deserves. It would have been a big help in structuring this presentation. However, as a limited substitute, please consider these excerpts from his paper:

A. From the list of alternatives we select the following which seem germane:

(1) Disseminate information

(2) Produce and distribute self-help manuals

(3) Adapt high technology to evolving needs

(4) Set up and extend the infrastructure for the measurement standards process

(5) Develop industry rather than metrology

(6) Develop metrology rather than industry

(7) Work on common LDC problems

(8) Follow NBS procedures

(9) Provide consultants

(10) Use existing engineering standards instead of pushing for new ones

(11) Make Standard Reference Materials available to LCD's

(12) Develop data systems

(13) Use labor-intensive instead of capital-intensive technology

(14) Speed up the applications of science

B. In the action column we find the appropriate entries:

(2) Consultation services

(3) Data programs

(4) Training programs

(6) Translate high technology to LDC needs

(7) Lead in the development of the measurement infrastructure

At the conclusion of my paper it will be helpful for us to check its proposals against these lists to see if they exhibit adequate accuracy, i.e., do they cluster on the true target?

We begin the analysis by noting that the excellent presentations of Drs. Tabor and Salama have given us a scholarly picture of the relationship between physical measurements and engineering standards. They bring us to a common realization that physical measurement is but one part of an interacting system comprised of units, measurement configuration standards, performance standards, quality control, and product certification. Measurement provides a necessary but not a sufficient quantitative basis for consistency and coherence in the integrated function of the whole aggregate. My emphasis on the measurement component to the exclusion of the others arises from practical considerations of time limits and program constraints, not from any desire to minimize the other components.

Mr. Cali as a part of his presentation gave us a unifying picture of the relation between accuracy, precision, and meaningfulness in measurement. To understand fully what I wish to propose, it will be necessary to extend Mr. Cali's picture by adding a fourth component of effective practical measurement--compatibility, which I am sure Mr. Cali omitted only in the interest of brevity. Table 1 briefly characterizes the four components:

Table 1 - Components of Effective Measurement

1. PRECISION

   - Reproducibility for
   - Design, Production, Quality Control

2. COMPATIBILITY

   - Pseudo-Accuracy
   - Transfer Accuracy
     - Internal
     - External

3. ACCURACY

   - Necessary for Barrier-Jumping
   - Sufficient but not Necessary for Compatibility

4. MEANINGFULNESS

   - In Specific Situations

Precision relates to the self-reproducibility of measurements. It shows how well the measurements cluster around a common center. It is an essential ingredient in design, production and quality control.

Compatibility is a sort of pseudo-accuracy. It shows how well different groups within the system, making apparently identical measurements, agree with one another; i.e., it shows if they are measuring the same thing and it is a measure of their mutual agreement.

I submit that the purpose of measurement, aside from the pleasure it gives the metrologist, is to provide compatibility between measuring groups so that if one outfit puts out a product it will be compatible with similar or mating products elsewhere in the structure, be it within the nation, outside the nation, or among nations. It is a transfer accuracy to insure interchangeability of parts in a mass-production economy. Thinking in terms of the scatter targets Mr. Cali used, we note that a tight group of hits wherever they may be on the target, represents precision measurement. Two marksmen may have comparable scatter-patterns located in different parts of the target. We say they are equally precise, but not compatible. If adjustment brings their scatter-patterns into coincidence, they are said to be both precise and compatible. If they are equally precise, are compatible, and center on the bulls-eye, they are also accurate.

Accuracy is a measure of how well hits group around the bulls-eye--the correct answer, which may be known before-hand or inferred from a group of precise measurements judged to be free from bias.

Clearly, if two marksmen are accurate they are also compatible. But they can be compatible while still inaccurate. Thus accuracy automatically insures compatibility--one important advantage of accuracy. It also follows that if one set of measurements is accurate, all sets compatible with it are also accurate. Compatibility propagates accuracy--an important advantage of compatibility.

It happens commonly in metrology that compatible measurements are much easier to come by than accurate ones, and often they are quite good enough. Consider electrical quantities as an example. The accuracy of electrical measurements at the top of the art is from 2 to 4 parts per million.

Compatibility within the U. S. is about 0.1 ppm. Other nations demonstrate similar capability. If each proceeds independently, their compatibility when they compare results will be about that of the top accuracy. This comparison of results takes place in the international forum of BIPM and harmonization (compatibility) is brought about by assigning correction factors to each nation's standards.

The internal U. S. compatibility is expressed by stating that instruments are calibrated to within 10^{-7} compatibility "in terms of standards as maintained at NBS." Reading the fine print shows that the accuracy of these national standards is 2 to 4 ppm. Standard cells which have been calibrated in France and also in the U. S. have shown differences in excess of the expected drifts in the cells and in excess of the two national compatibilities. Resolution of the differences emerged as soon as it was realized that each nation was calibrating in terms of its own standards. Application of BIPM corrections brought the measurements into full compatibility.

Because compatibility propagates accuracy, any improvement in the state of the art in any standards laboratory is felt immediately throughout the system. This justifies large expenditures of effort to attain accuracy in a few places. In the meantime the advantages of compatibility can be enjoyed without waiting for accuracy. Why then do we seek accuracy at all? Products made with precise compatible measurements will mate, perform, and become fully interchangeable. This is true, but it no longer holds when one crosses boundary lines in fields of science. If, for example, electrical measurements are used to check out thermal or mechanical devices, then true accuracy plays the major role and compatibility is not sufficient. To provide the coherent measurement system necessary for jumping the barriers between various realms of science and engineering, accuracy is essential. However, to manufacture interchangeable products for the marketplace, only the pseudo-accuracy of compatibility is needed. This has often been forgotten, and as a result extensive resources have been wasted in an unnecessary quest for that expensive luxury--true accuracy. Since compatibility propagates accuracy, any establishment whose measurements are compatible with those of some other establishment which has traceable compatibility with a central laboratory will also have traceable compatibility, and associated with it all the accuracy characteristic of the measurement infrastructure. It is only necessary to tie into the structure at one place to be compatible with all of it.

It appears, therefore, that small establishments, in the U. S. as well as in the LDC's, can be content with compatibility of the self-evaluation variety and can take advantage of the fact that comparative or differential measurements are usually much easier, much cheaper, and less capital-intensive than absolute measurements. Of course, some large establishments may consider that they need true accuracy primarily as an image-building status symbol, and this pose is not limited to LDC's!

Meaningful measurement. We can leave this component with the passing observation that it relates to really measuring what you think you are measuring in a practical environment--such as the temperature of a red-hot strip of steel shooting through the roll stands in the mill. The problems are many, complex, challenging, important, and as varied as the applications of measurement. However, since considering them will not aid our present discussion, we reluctantly pass them by.

We should by now have focused our attention and come to agreement on the fact that the primary need of any establishment is a traceable, compatible coupling to the measurement infrastructure at whatever precision levels and ranges are adequate to its requirements. We turn attention to how establishments with limited resources, whether within or outside the United States, can obtain this coupling, and how NBS can move to help them. While listening to the other speakers I have been reviewing mentally the developments of the last couple of decades which may offer promise for what we seek to achieve. The thought-provoking comments by Dr. Condon started my train of thought. He pointed out that social change is generally slow, and that even revolutionary change comes about with a time-constant of a decade or two. When I view current measurement developments with this in mind I can see that we are in the early phase of what appears to be a revolutionary change in the measurement infrastructure and the means of coupling to it. Most of these developments have been mentioned already in this conference--some only in passing. When they are examined explicitly together with their mutual interactions and implications, they comprise an important aggregate well worthy of our attention. In fact, I think we should shine a spotlight on them, jump up and down and yell "Achtung!"* Their potential for progress signals a revolution in the making.

In Table 2 we see grouped together four main accomplishments under the heading--milestones. The first refers to the fact that the basic SI units, with the one exception of mass, are now defined in an independently reproducible manner. This extremely important development of the last decade has hardly been mentioned here--I suppose because we already take it for granted. But observe the significance: physical standards are no longer artifacts. They have become, in the words of Dr. Branscomb, an algorithm, a recipe for an experiment which can be performed in any laboratory equipped to undertake it. In this country, for example, there are two main realizations of the second which have demonstrated compatibility of about 5 parts in 10^{13}, and some twenty realizations of the length standard with compatibility approaching one part in 10^7 or better.

Table 2 - Milestones

1. Independently Reproducible Standards

    a. Basic SI Units
    b. Tie-Points

2. Standard Reference Data

    . Quality Control of Data

3. SRM's for Metrology

4. Self Calibration

    . Calibration Mythology
    . Traceability Morass
    . MAP, Pilot, A Way Out

The significance for us here is not that more and more laboratories can and do undertake these experiments, but rather that the principle can be extended to the easier job of fixing tie-points along the range where the compatibility requirements are less stringent. It can also be extended to the SI derived units for all non-basic quantities in a way which provides compatibility and propagates coherence. Thus it becomes possible to have a series of tie-points, interface connections to the measurement infrastructure, which can be used independently by any laboratory. As we shall see, this can be done in what is called self-evaluation mode. The extension of this principle of independence rests upon accomplishments indicated as 2, 3, and 4 in Table 2. All three are involved in an integrated, cooperative manner. We start with item 4, which displays the fundamentals.

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* Exclamation in German language signifying: "take careful note."

An inherent mythology which tends to gloss over important deficiencies has grown up around the very principles upon which the achievement of compatibility-by-calibration rests, and around the whole traditional hierarchical structure of the system based on these principles. The general and widely acknowledged purpose of measurement is to arrive at product-compatible measurements by a process involving instruments, people (hopefully metrologists), and procedures. The mythology is this: If the instruments are calibrated by a parent establishment against instruments at a higher echelon of accuracy the result will be compatible measurements. The fallacy is obvious--there is no guarantee that the instruments stayed calibrated, that the people used them correctly, that the procedures are suitable, or that the whole process is in a state of control. This mythology reached a peak of fantasy when certain military agencies introduced in some of their contracts a legal requirement for "traceability." The idea of traceability is a pious one, full of benefits; it is a step in the pursuit of a wonderful goal. But the ongoing mythology quickly limited it to traceability of calibration, which in turn has led us into a morass of complications, contradictions, and meaningless props. This is because the contractual specification of the associated processes lies beyond the scope of a system founded on the calibration concept.

The NBS Measurement Analysis Program (MAP in Table 2, item 4) mentioned earlier in the conference affords a way out of the morass. I find it convenient to use the term self-evaluation (S.E.) to describe it. The fundamental idea is beautifully simple. Send the metrologist something to measure (an S.E. device) instead of having him send you his instruments for calibration. Give him also the correct answer for the measurement of the device. He can then make repeated measurements of that S.E. device until the precision of the instrument-people-procedures aggregate becomes clear. If the center of his scatter-pattern agrees with the right answer, his whole process is in control, his measurements are compatible, and his accuracy relative to that of the parent source will be shown by the width of his scatter-pattern. If the answer does not agree he can correct his instruments, in effect, calibrate them himself, and repeat the procedure to get a new answer. This process goes on until the answers do agree. Note in passing--if you do not trust the integrity of the metrologist, do not send him the correct answer. Have him send you his scatter-diagram. Send back to him a correction factor and a figure of merit for his process.

The compatibility, accuracy, and traceability acquired this way are meaningful. Their continuity can be assured by interleaving measurements of the S.E. device day after day with measurement of the industrial products for which the whole process was established. Extended continuity can be provided by arranging the parent laboratory to keep a supply of S.E. devices flowing regularly. A most important property of S.E. emerges here. No longer needed is the chain of calibrations through several echelons from the central laboratory. The S.E. device provides a one-shot horizontal transfer from central laboratory direct to user. The demands for extension of top-level capability are reduced, and effort can be devoted to the accuracy truly needed at the most crucial spots in the system, instead of being dissipated in losses at intermediate calibration echelons. Moreover, the metrologist can no longer cheat himself in the way described by one of our earlier speakers, by putting his beautiful traceable calibrated instruments on the shelf, and taking them down only for submission up the line in evidence of his traceability.

A little reflection then shows that S.E. has accomplished:

1. Compatible measurement

2. Precision suited to local needs

3. Transfer of accuracy

4. Unambiguous, continuous traceability

5. Verification of statistical validity of local processes

6. Calibration of local instrumentation

7. Elimination of the calibration hierarchy

8. Pressures to keep the metrologist honest and on his toes.

This S.E. process has been used for many years, with gauge blocks, for example. Then, what is new? A realization that this is a fundamental principle applicable to other quantities. Applications to mass measurements are described in NBS documents available at this meeting. Extension to voltage and temperature is now under way at NBS.

By now it has probably occurred to you, as it did to me, that there may not need to be a flow of S.E. devices from the infrastructure to the using establishment. A supply of correct answers is ready at hand, in the form of Standard Reference Data (SRD, item 2 in Table 2). Perhaps it would be better to say, a supply could be at hand if there were enough SRD. SRD provide precise, accurate, reliable information on the properties of well characterized matter and materials. "Well characterized" means that the description of the material is adequate to insure the user that his material, if it fits the description, will give the same answers, when measured, as those in the published literature of SRD. When such data are available, a central laboratory meets its obligation to S.E. either by calling attention to the data or by publishing the data and characterization of the material. A metrologist desiring S.E. need only get some of the material, or perhaps produce it for himself in terms of the given characterization. He then measures it and compares his results with the published values. He then proceeds in the usual S.E. manner. He should select only those substances for which the precision, compatibility, and availability meet his needs.

An illustrative story is helpful at this point. A few years ago I visited the physics department of a university of moderate size. This establishment had need for access to the measurement infrastructure, had limited resources, and no standards laboratory. I sought and received permission to interview every member of the faculty (of that department) and their graduate students about their measurement procedures. In each interview I asked the respondent how he satisfied himself that the measurements he made and subsequently published were in fact accurate and compatible with the measurement infrastructure of physical science. The immediate response was consistently "Huh?", indicating no recent explicit consideration of the matter. This was followed after a little discussion and reflection with one or both of two responses:

(a) "I accepted the manufacturer's calibration of my instruments."

(b) "I measured the _____ of _____ (say, melting point of butter) as published by Dr. Zilch and adjusted my apparatus until I got his answer. I then proceeded with additional similar measurements."

Here we see first an acceptance of the calibration mythology. Also, we see an intuitive use of the SRD-SE process.

Again we note that reference data are nothing new. The International Critical Tables have for years been a familiar and trusted source. Using SRD for S.E. calibration is not new, either, as we have seen. The new, encouraging aspects of more recent origin are:

(1) The idea, backed by a national program, to make a systematic

evaluation of all published data, to arrive at "best values" having stated accuracy and reliability.

(2) As a result of the undertaking, a recognition that a large fraction of existing data is not evaluable, and therefore not traceable, because of the absence of essential information about procedures used and sources of subsidiary information.

(3) Stemming from (2), a recognition of the need for and initial undertakings to develop and promote the use of proper quality control criteria for the production of reliable compatible data.

These new features should do much to bring to availability a much-improved body of SRD.

You may well be wondering where SRM's fit into this picture. The need for them in the measurement process is very clear and real. In many cases it is difficult or impossible to characterize a material sufficiently well for someone else to reproduce it. In others the characterization process is so complex that it lies beyond the capability of the user or is so costly that the process is uneconomical. In still others the necessary starting materials may not be available to the small establishment. In this case, the parent laboratory producing SRM's says, in effect: "I know that for one reason or another you cannot reproduce my material. I have lots of it. I will sell you a small portion of mine. If you measure it correctly you will get my answer which I will give you with the sample. You can use it for your S.E. process."

This is the basis for those SRM's supplied by NBS and intended primarily for calibration purposes. As you well know, SRM's are not new. The new features are:

(1) Realization of the capabilities of SRM's for traceable compatible measurement.

(2) Explosive expansion of the variety of SRM's purposes.

(3) Rapidly increasing use of SRM's for S.E. purposes.

The nature of an assistance program now begins to take form. The four items shown on Table 2 provide a stable of capabilities which can help any metrologist to accomplish S.E. and become traceably compatible in his own house. Action is required to extend this capability to meet existing and reasonably foreseeable needs, and to do so at points of range and levels of compatibility suited to the needs of developing establishments wherever they may be. The needs throughout these United States are great enough to justify the effort. One need not rely solely upon pressure from the LDC's to bring it forth.

I think you will agree with me that it is not enough to make the general recommendation, which we can and do give here, to press forward on S.E. devices, SRD's and SRM's, and independently reproducible definitions of units. Something more explicit regarding focus and distribution of effort should be added. This focus can be achieved with the aid of a diagram generally and loosely called an "accuracy chart." An idealized one is shown in Figure 1. One such chart can be used for each measurement quantity such as length, mass, voltage, current. The abscissa displays the range of measurement, from 10^{-x} to 10^{x} times the unit quantity. This indicates that measurements ranging from fractions of unity to multiples of unity must be available and must be connected by a chain of measurement to the standard representing the physical realization of unity. In length, for example, this chain extends from the meter downward to subnuclear dimensions and upward to hypergalactic dimensions. The ordinate represents precision, accuracy, or compatibility, as the case may be, expressed as one part in 10, 100, 1000 ... 10^y.

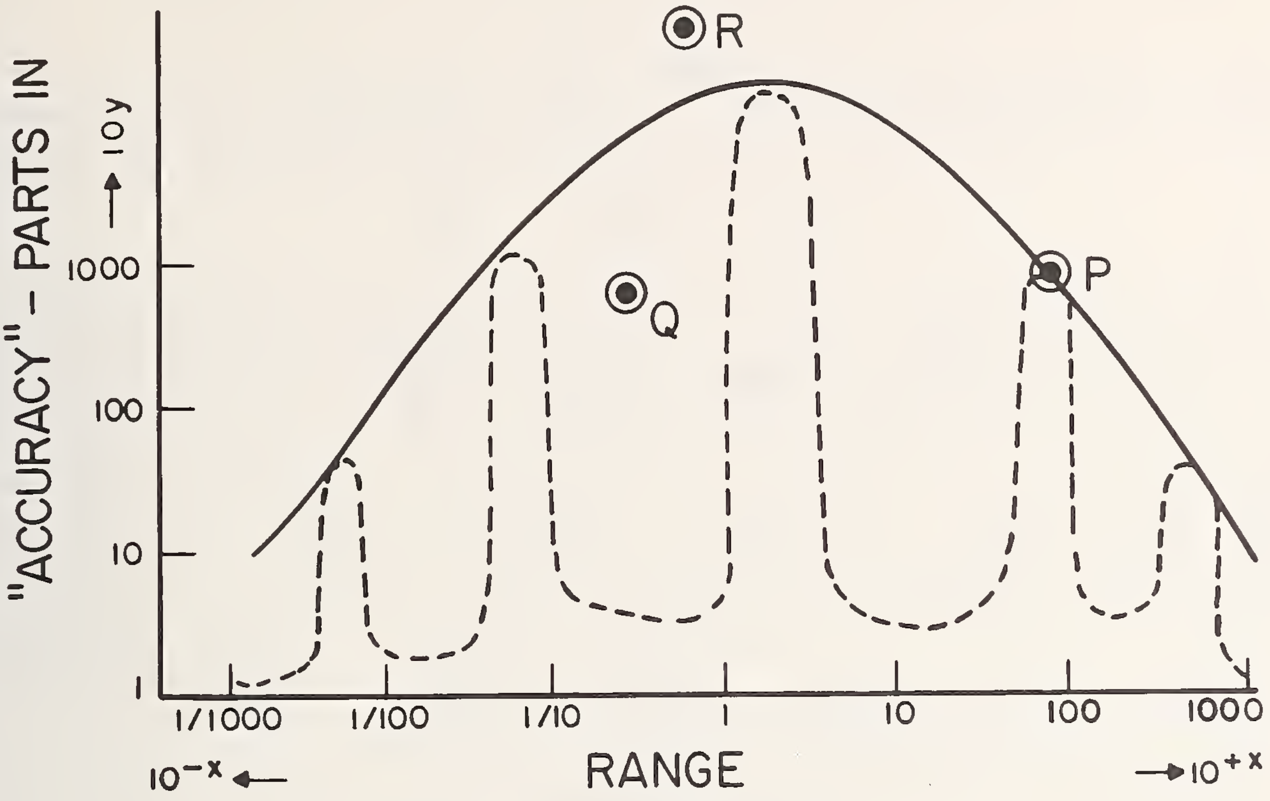

Figure 1 - Idealized Accuracy Chart

The solid curve, an idealized case, shows the best available "accuracy" of measurement at the range indicated on the abscissa. Point P on the curve, for example, indicates that at point 100 on the range scale an "accuracy" of 1 part in 1000 is available. A point such as Q represents a typical measurement requirement for which less than top-of-the-art accuracy is needed. A point such as R represents a requirement beyond the state of the art. The general falling off of the solid curve as the extremes of range are approached reflects the common experience that accuracy suffers as the chain of measurement extends outward from the standard at unity. In a situation more realistic than that indicated by the solid line, measurement capability is most fully developed at isolated spots or segments along the range axis. At these selected positions, accuracy approaches that of the solid curve, while between them the accuracy falls off. The dashed curve is representative of some cases.

Points such as P, Q, R can also be used to represent what we may call tie-points into the infrastructure. Suppose a metrological laboratory needs measurement capability indicated by Q. The metrologist needs to know where and how to tap the infrastructure to acquire capability Q. A more detailed picture of such situations is depicted roughly in Figure 2. As shown here the circles represent only my guess as to what might be expected. With a little effort a realistic picture of this kind could be made. Then the circles would represent the availability of tie-points into the infrastructure. Those marked with an X would represent tie-points at which S.E. service is available. The squares indicate established needs for which capability does not yet exist. Every metrological establishment, be it shop, laboratory, factory, industry, university, college, or high school--not only in LDC's but in this nation and others--needs to tap these tie-points.

There should be available also the knowledge and procedures on how to develop in an S.E. manner the compatible, traceable measurements suited to the local needs.

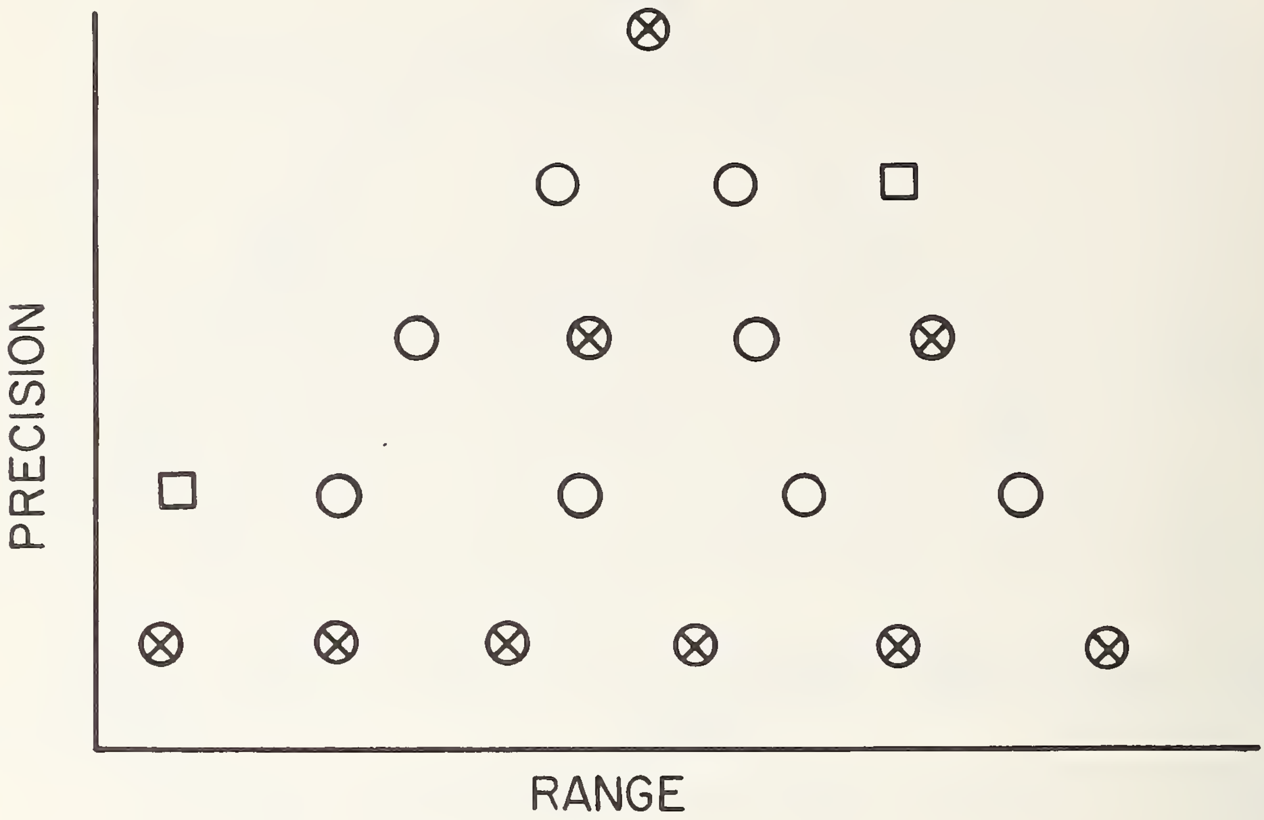

Figure 2 - A Detailed Accuracy Chart. Open Circles Show Tie-Points; Crossed Circles Show Self-Evaluation Aids; Squares Show Unmet Needs

A more specific proposal can now be addressed to the conference and to NBS. The proposal takes the form of a sequence of suggestions grouped into phases.

Phase I

(1) Arrange for the production and continuous updating of a real chart like Figure 2 showing available tie-points and needs.

(2) Insert X's as appropriate.

(3) Append to each X a subscript SRM, SRD, or MAP indicating the availability of such services.

(4) Arrange for publication and dissemination of these charts.

Phase II

To be truly useful, the numerical value available at any tie-point should be accompanied by "how-to" documentation which explains the procedure needed to make effective use of the service available at that tie-point. In this regard NBS can:

(a) Describe its procedures for those tie-points for which it provides services.

(b) Add to the Phase I charts the additional subscript DOC on the X's to indicate that how-to documentation is available.

Phase III

Completion of Phases I and II will indicate where the gaps lie, and the squares will show where unmet needs lie. NBS can undertake to meet some of the needs which call for its unique capabilities. Phase III will require some modification of the ongoing program.

Phase IV

This phase goes far beyond what any national standards laboratory can do for its national measurement system. It calls upon each national laboratory to exert its leadership to stimulate and encourage the metrology infrastructure to lift itself by its own bootstraps. Each tie-point such as Q--which requires less than top-of-the-art capability, but which is no less important because of that--presents an opportunity to some establishment in the infrastructure. A metrologist can survey the situation and find a combination of MAP, SRD, SRM which will enable him to develop as a research project the required S.E. capability characteristic of that point. Then, he can check it out with a parent laboratory, if necessary, and then publish the how-to documentation as a contribution to the infrastructure while also meeting his own needs. In Phase IV NBS can:

(a) Encourage other national standards laboratories to collaborate in the process of infrastructure extension.

(b) Encourage all establishments with which it has contact to make such contributions.

(c) Keep updated charts of the status of tie-points.

(d) Invite guest workers to come to NBS to work out specific tie-points.

(e) Arrange to pay some metrologists from abroad to work at NBS in making similar contributions.

(f) Place contracts in LDC's with regular or counterpart funds, as appropriate, to develop, in-house, identified tie-points.

Conclusions

Suggestions emerge as a sequence of things that can be done throughout the metrology infrastructure to help it grow by itself. NBS has a part to play. Other national laboratories can contribute similarly. More importantly, the national laboratories can encourage and support the network of using establishments to make specific additions. Every element in the structure becomes a possible contributor. The contributions can be labor-intensive or equipment-intensive, depending upon the facilities of the individual establishment.

Hopefully, when a metrologist turns to a tie-point, he will find documents prepared by others on how to develop an S.E.-type of capability which is fully traceable and compatible at appropriate levels.

The horizontal-transfer characteristics of the S.E. process can relieve the upward pressure at the top of a calibration hierarchy--brought about by too many calibration echelons--and can put the calibration capability in proper perspective. Increased accuracies need be developed only where the need is real and is not merely the result of multiple echelons of calibration.

Someone mentioned earlier that the practices of NBS, a father-figure in this business, might not be appropriate to the needs of LDC's. I claim that the impending revolution in measurement indicates that existing calibration practices are not necessarily appropriate to NBS either.

We leave it as an exercise for the reader-listener, first, to determine how well these suggestions meet the needs we listed earlier, and then to express their points of view to NBS. The concept of a cooperative structure with built-in feedback, triggered by leadership and continually improving itself, is a truly exciting one.

Paper 8.3 - Preparing Product Specifications

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In contemplating this joint NBS-AID Seminar, I have been particularly interested in the interaction between our experience in this country, the objectives of AID, and the needs of the less developed countries of the world. It is with this combination of concerns and viewpoints that I would like to review some of the things which I have observed during my short period here. I would like to set the stage for some fairly specific recommendations which will cover a wide range, but at the same time may focus attention on the needs which have been expressed particularly by our visitors from abroad.

I was asked to summarize the discussion here as it pertains to preparing product specifications. Our overall Seminar has concerned itself with industrialization. I regard industrialization as the production of goods and services according to a specification; thus, specification is intrinsic. We are, furthermore, concerned at this meeting with the role of metrology and standardization. Someone remarked this morning that it is extremely important for us to recognize the distinction between standardization and specification. Too often there is a tendency to bypass specification and merely use standards. This is inadequate. It is important to recognize that standards are used in preparing specifications, which are in effect a description of product in terms of quantitative standards. Thus, industrialization, if you accept my definition, cannot develop without accepted practices of metrology and standardization. These are inevitably coupled together. If you have this coupling you can then begin to talk meaningfully about product quality because you have some way of measuring what you mean by quality. We might think of quality in terms of durability, maintainability, reliability, safety, usefulness for the public and general public well-being, but in fact, quality really depends on meeting the specifications which are set up in order to meet market requirements. Consequently, as has been pointed out at this meeting, quality control is an essential follow-up to specifications.

As we look at industrialization of developing economies, I think it is useful to review the evolution and growth and sophistication of markets. Almost any economy depends basically on goods for local consumption. People have to eat, have clothing, have housing, have the simple tools with which to earn their livelihood. At this level, even in the most unsophisticated environment, there appears some evidence of quantitative description. Thus, there exist the first rudiments of specification and there is a start towards utilization of standards. As a local community expands its market and begins to deal in a regional domain, it becomes concerned with those fabricated products which enter into regional trade. Once this begins to happen, the need for adequate quantitative identification, which then means specification, becomes more insistent. Such public requirements may be derived from customs or from a community or regional consensus. Especially if these are informal, they will depend very greatly upon the confidence which the consumer has in the producer, and in the effective specifications which the producer uses. Whether or not these are formally stated, the need for confidence must be understood at the outset.

As we consider an industrialized economy or one that is becoming industrialized, a whole pattern of specifications must be set up, in order that raw materials can be properly used, in order that components can be transferred from one fabricator to another, and in order that there will be general acceptance of the goods to be sold in the market. At this stage (and several people here have pointed this out) in many of the less developed countries it is extremely important to recognize the necessity to accommodate to the realities of limited economic resources and limited skilled manpower. Thus, while we might suppose that a sophisticated standards program was desirable and necessary in order to have adequate specification, the realities of the situation may make this quite difficult. Nevertheless, there eventually arises a situation where the establishment of sound specification practices is quite essential. First, consider the matter of interaction in foreign markets. It is practically impossible and certainly undesirable for any country to endeavor to participate in foreign markets without a system of specification based on sound standards. There might be temporary advantages, but ultimately critical disadvantages will appear. The other reason, pointed out by Dr. Ghosh this morning, is service in the public interest. It is well recognized that proper use of standards and specifications does result in production efficiency. It results in far greater and more effective use of products and natural resources as well as manpower. In addition it results in better protection of the public and better service to the public. So as any country evolves in its industrialization, these points should be recognized and the proper steps be taken in its own interest.

As we look at the situation in the underdeveloped countries, we realize that almost any market in the world is concerned with the simpler sorts of measurement, even if merely counting or weighing. However, the sophistication that can be acquired in any environment is critically dependent on what instrumentation is available. As has been pointed out on a number of occasions yesterday and today, the development of an adequate system for developing good specifications is frequently handicapped by inadequate instrumentation and inadequate testing facilities.

Standardization and specification are evolving concepts, beginning with the most common quantitative identification with regard to goods and services. Anyone who wants to buy something has to know something quantitatively about what it is that he is buying. Consequently there evolves a pattern of quantitative identification. The specifications are dependent in each case upon the market to be served, and the standardization which is required will depend very much on the particular market pattern--the structure of that market, the goods and services that are found there. They will differ substantially from one market to another. The unique characteristics of these market domains as they reflect through specifications on the standardization are factors that need more adequate clarification.

One of the things which has been mentioned over and over again is the development of a standardization program for the developing countries. This takes good manpower, usually in short supply, and that forces a trade-off between the economic and public advantage on the one hand and on the other the difficulty of satisfying adequately the national needs. There has been discussion regarding the evolution of standardization and specification systems from the simplest labor-intensive work to a sophisticated industrialization. In this evolution you encounter the problem of enforcement and public acceptance. Shall control be in the hands of a government agency, an industrial or trade association, or a consumer organization? If you are going to have meaningful measurement, there needs to be some mechanism for control and some means by which quality control practices can, in fact, be made effective.

With this background then, what are some of the services which might be developed to help a developing country toward better product specification, better standards, and better metrology practices? First of all, the basic need is for education. The development of quality control awareness, the training of standards engineers and technicians--the whole pattern of how to go about writing specifications and utilizing standards--needs to be handled much better than it is now. While this is not too specialized an art, the educational resources in many of the underdeveloped countries appear to be inadequate. Consequently, I propose a thorough study of how these resources can be provided by other parts of the world, particularly by this country. In general, the technological and engineering education system in the USA has not been designed to serve effectively the requirements of a less developed country. Too often bright young men come to this country to study engineering, but end up by being scientists, with no interest in quality control at home. I might mention that the Academy of Sciences and the Academy of Engineering are working with AID right now on a study of what might be done. It will consider not only ways to improve our own educational system for the foreign student's needs, but to offer service to foreign universities in their educational programs. Both aspects require attention. I might also mention that we ought to give a great deal more attention to the transfer of packages of education. While NBS can put on a seminar or a whole course in metrology or standardization, it is impossible for most individuals in other parts of the world to come here. It seems to me that such a course might well be packaged and sent abroad. It should be designed for use in the country to which it is going, in recognition of the specific needs of that country. I am convinced that this can be done extremely well; it would provide an interesting and exciting approach to many parts of the world.

Another specific concern that was mentioned a number of times is the need for testing facilities. You cannot maintain adequate quality control unless you have a testing facility appropriate to the market in the country with which you are dealing. A great deal of attention needs to be given to the know-how required to establish the testing facility, its equipment and instrumentation, and its compatibility with that country's manpower resources and economic resources. Financial assistance alone is not enough. It is never easy and not always possible, for underdeveloped countries to identify their requirements. There needs to be help from some agency in the design and development of the facilities which will serve their needs best.

I find it surprising that there is no readily available source which describes adequately the diversity of specification practices in different market areas of the world. It seems to me that it would be extremely useful, particularly for the less developed countries, to be able to define their own market, compare it with another market in another part of the world, and then use recorded information to see what practices on specifications and standardization had been adequately developed for that country. There is a need for an adequate reconciliation of these different practices, because something set up here might take a different form in another part of the world. How do you develop in a small local market a pattern which will be adequate for a much larger and a much broader international market? There needs to be better information on the various formal mechanisms for achieving standardization, including both national and regional systems. How do these relate to one another and to the ISO pattern? Let me suggest the need for the development, perhaps through ISO, of what might be called prototypes for national standards for developing countries. The ISO standards themselves are not designed for that purpose, and something might be designed which would better serve the interests and needs of less developed countries.

Another area of interest is the standard reference data and the standard reference materials provided for use in this country by NBS. Could these services be expanded with AID assistance, for example, to serve

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specific market needs in other parts of the world? These market needs may be quite different from those in this country. This could be a most useful service for those developing countries which cannot yet develop a standard reference data or standard reference material program.

Finally, there is the important question, discussed at length this morning, of the role of the ISO in relation to the needs of the developing countries. The ISO serves usefully in the highly industrialized economies in the world. It has been pointed out that the standards set up must perforce be focused on the requirements of these countries, primarily the countries of Western Europe. How can you establish and finance a program which will in fact provide direct service to less developed countries? There is also the question, as was pointed out this morning, whether you should consider the possibilities of a regional market. This is very important for the less developed countries. If their standardization practices are not coordinated with their neighbors and in some way with international standards, they may very well establish standards which later will have to be changed drastically with loss to all concerned. However, the developing countries may be forced to follow such an unsatisfactory course if they are not given enough help.

NBS SPECIAL PUBLICATION 359 - Metrology and Standardization in Less-Developed Countries: The Role of a National Capability for Industrializing Economies.
Proceedings of a Seminar, 1971.

Paper 8.4 - Disseminating Information

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This whole Seminar has been concerned with the communication of information. We need now to investigate how best to continue that communication. We also need to analyze the information that we have received from each other and use that information to reach decisions on what to do next. In an article about management that I read recently, I found a definition of the management process that I would like to quote. It states: "management is the conversion of information into action." That is what we want to do as a result of this Seminar. We intend to convert the information that we have gathered during this week into some sort of action; at this moment we are not sure what that action will be.

Cushen's analysis reported to us earlier today can be used to show the significance of information gathering. I counted the number of alternative actions listed in his analysis; there are 59. All of them to some extent have an information content, but of these 14 are concerned primarily with information gathering and dissemination. This large number of especially information-oriented alternatives is an indication of the significance of the concept of information handling to the subject of this Seminar.

In developing an action program, we need to ask two questions. First, what are the needs of the less developed countries for information on standards and metrology--in the general context of needs for information on technology and science and their application to economic development? Second, how can NBS help to satisfy those needs for information?

First, I shall address the first question, emphasizing that technical information is not documents. You heard a great deal yesterday from Melvin Day formerly of NASA, presently at NSF, about sources of documents in the United States Government. He described the National Technical Information Service, the activities of NASA, AEC, the Government Printing Office and a number of other agencies of the government. The NTIS estimates that approximately 100,000 official government documents of the type that contain information of interest to its user community are produced each year. Does any developing country need all those documents? The answer is "Certainly not." Does any single agency in the United States need all those documents? The answer again is "Certainly not."

I want to repeat and to emphasize one bit of advice given yesterday by William Knox, the director of NTIS. He said, "Don't put your information system in the hands of a documentalist." That is good advice for all the countries of the world, including the United States. A corollary of this advice is his additional statement, "Don't use a shotgun approach to information, use a rifle; aim for exactly the information that is needed rather than trying to bag all of it and then make sense out of the whole lot."

For standards and metrology work one needs information on the following subjects: (a) national standards adopted by other nations; (b) standards adopted by international bodies; (c) measurement techniques and characteristics and behavior of measuring instruments; (d) relevant legal requirements of other countries and of international bodies; (e) organizational practices; and (f) standards-making procedures. For example, everyone would probably want to study the standards-making procedures of the United States so you can be sure to avoid what we do wrong.

For the total process of industrialization, other types of information are needed. Some may be obtained from outside sources, because it is characteristic of the basic properties of materials and manufacturing procedures. Some is necessarily internal, because it is characteristic of the particular organization that uses the information or the country in which it is being used. To illustrate, I will mention a few of the many types of information needed. Information is needed about products, manufacturing processes, and the availability and prices of the materials used in manufacturing. Information is needed about the availability and cost of capital, about customs, export regulations, and other non-technical matters. If you set out to do the marketing studies that we heard about yesterday from the Ford Motor Company, your information gathering needs seem enormous indeed.

The multiplicity of U. S. sources and the difficulty of maintaining current awareness of new developments suggest that the collection of information from United States sources might best be handled by a centralized mechanism located in the United States, probably in Washington. Collection of information can be an expensive operation, although non-collection can be even more expensive. Efficiency demands that information gathering be carried out on a reasonably large scale, which means probably that there must be cooperative effort. Regional or multi-national cooperation in sharing the resources and the effort is probably quite essential for an effective operation. I would recommend further that any center established for gathering information not be just a transmittal agency for picking up documents and passing them on, but that it be an information analysis center in which knowledgeable scientists and engineers would select appropriate information from the documents and interpret it in the light of conditions in the country in which it is to be used. This means that the people in the center must be knowledgeable in various fields of science, technology, economics, and law, rather than librarians.

However, preliminary analysis in Washington needs to be supplemented by further review, interpretation, and analysis on the scene where the information is to be used. A possible instrument for that purpose is the local university network and the system of government laboratories. In this way local universities can make an important and major contribution. Another important function that a center in Washington might carry out for the people on the scene abroad is to help to confirm their local analyses and interpretations by drawing upon expertise in universities and other centers of competence in the United States. When people feel that they are a great distance away from centers of information and action, they are sometimes unsure whether they have taken into account all the important considerations. Thus, the center in the United States can help to give assurance that something important has not been overlooked. This form of moral support is considered to be quite important by people who have had experience in developing countries.

When I mentioned connections with United States universities or laboratories that might participate in the information gathering and interpretation function, I had in mind institutions such as Battelle Memorial Institute, which has had a great deal of experience in this area. Let us immediately include the National Bureau of Standards in the list of laboratories capable of providing such assistance to the less developed countries and interested in doing so.

Now, let us turn to NBS and consider what information activities we might undertake in cooperation with and supported by AID. NBS is a major national resource, with a broad mission to strengthen science and technology in the United States. We are trying to understand in detail how best to carry out that mission. We are analyzing our activities, and shall continue to do so, in order to find out exactly what our role is in the economy of the country and how our services strengthen the technology upon which much of our economy is based. For that reason, Dr. Branscomb has told me that he wants especially to encourage a program with AID that would not only aid the less developed countries but would help also to contribute to our intellectual understanding of the development process generally and the role that we play in the developing economy of the United States. In designing our program, we shall keep this injunction in mind at all times. We shall want to help the developing countries formulate questions about their own needs and the activities that might be undertaken to help to satisfy those needs. We might, for example, analyze the needs for standards and metrological capabilities in the areas in which our capabilities mesh well with the needs identified by some of the earlier speakers in this Seminar.

Some current activities at NBS seem immediately applicable to needs that have been expressed. We shall be especially interested in the advice that we shall receive from the Seminar participants in the written statements that we have requested (see Appendix 2). The comments received so far are very thoughtful; I consider them to be of very great value indeed in guiding us in the future.

Now, I would like to give some examples of activities that might be undertaken quite readily. We might, for example, select a library of standards and metrological literature needed in the standards laboratories of the participating countries, and we might also help in the procurement of that library. We could provide information from the active information centers at NBS. You may recall that one of the slides used by Dr. Kushner listed those information centers. Copies of his slides are available so that you can get an idea of the technical areas in which these information centers are working. We can distribute our NBS publications to any laboratories that wish them. We might organize workshops on specific topics of interest in the metrological and standards field, consulting the countries participating in the workshop to decide on the content of the program. We might receive AID-supported participants in the precision measurement courses run by NBS every year. Typical examples of recent courses are "Technology of High Precision Measurements in High Frequency Electrical Measurements" and "The Statistical Design of Experiments." These courses last several days each and are normally operated for U. S. industrial participants for a fee. We might prepare a movie for educational purposes on a selected topic in standards or metrology. We might also aid in the evaluation of the technical quality of the testing and development laboratories found throughout the countries participating in the program. We are engaged in that exercise now in the United States, not as yet in evaluating laboratories, but in deciding how to evaluate them.

The list I just presented is not intended to be a shopping list from which anyone can check off the items they want. It is intended as an illustrative list to indicate the types of activities that we might undertake in our program of cooperation with AID and the less developed countries. We look forward to receiving from all of the people here at this meeting further guidance to help us develop a continuing program.

SESSION 8 - GUIDANCE FOR NBS TECHNOLOGICAL ASSISTANCE EFFORT

Discussion

Co-chairmen, Part A: Mahmoud Salama and Allen V. Astin

Dr. Ghosh:

I should like to reiterate certain of the suggestions that have already been made by Dr. Hall. There should be some help given for the establishment of an international training center. In India we have been working with the United Nations on this idea. Hopefully, the UN may decide three years from now to set up this training center for standardization. Here I mean standardization for industry, not metrology. We are offering various countries Institute Fellowships, but the funding given them is inadequate to attract the best of personnel.

Send to underdeveloped nations experts who can impress the authorities concerned with the necessity for instituting standardization bodies. Standardization is a management responsibility and it is often very difficult for local people to convince the ministries that measurement science and product specifications are effective tools.

Again, to help in establishing calibration centers for engineering and measuring instruments such as gauges, experts should be sent from the USA to the less developed countries, and from the less developed countries to this country, to exchange ideas and information. The need for this work is very extensive in a continent like India, yet we have not enough capacity to give these services to a lower echelon of metrology. Greater collaboration should exist between NBS and the metrology and instrumentation departments of other countries. Hold training courses in the less developed countries as has been suggested by Dr. Hall. The faculty members could go from here, which arrangement has the advantage that they would obtain an idea of the problems that exist in the less developed countries. Otherwise, there is always the likelihood that the training might be a little over the heads of the participants who come from less developed countries. There should also be testing facilities augmented for industrial work as well as training in the fundamentals of metrology.

Mr. Tam:

Without referring to any particular paper I have a comment. Many of the speakers have emphasized the importance and the readiness to assist less developed countries in setting up facilities for measurement standards. Now this is certainly justified in the sense that measurement standards are the backbone for technological progress. However, under the conditions and for the needs of a country in the early stages of development, what is needed may not be so much the capability to make precise and accurate measurements of the basic quantities, but rather the capability to make reasonably good measurements of the properties of materials and products which will satisfy immediate needs. Measurement standards are relevant to industrial development only when they are used to support the implementation of engineering standards. Laboratories for measurement standards introduced in an early stage of development will have few customers, and I am afraid will serve merely as a showplace. Therefore I would like to advise NBS and other organizations in this country to spend their effort on programs to help developing countries set up industrial standards, product specifications, and test facilities, as Dr. Hall just said, to satisfy the needs of the market. This should come parallel to or even before the introduction of measurement standards.

Co-chairmen, Part B: Harry R. Tabor and Frank L. LaQue

Dr. Tabor:

While the Seminar talks were developing various ideas, I became more and more confused as to what part the NBS could play in advancing metrology and standardization in the less developed countries. This probably echoes the feelings of some of the other foreign delegates, but as this Session draws to its close, I begin to see light at the end of the tunnel. I must confess that I speak from the viewpoint of one concerned with metrology--precision measurements and calibration--rather than as one concerned with standardization, where I believe the situation may be far easier.

In the field of metrology the problem stems from the very large technological gap between NBS capabilities and obligations, and the metrological needs of a less developed country. The gap is so large that in most cases no useful dialogue is possible despite good will on both sides. This same technological gap, which of course we understand to be economic, logistic, and ecological and not intellectual, also exists between the NPL in Teddington and the less developed countries, but in Britain there is a difference. The British Calibration Service, exists as a group of laboratories, one step lower than the NPL, yet directly supervised by the NPL. These laboratories do not make re-evaluations of the basic constants of physics, but their measurements are more than adequate for the vast majority of industrial and even scientific needs in Britain. They would be certainly more than adequate for needs in developing economies. A father-son relationship between the British Calibration Service and a metrology laboratory in a less developed country seems to me far more realistic than a grandfather-grandson connection with the NPL itself. To the best of my knowledge there exists no real USA equivalent to the BCS, even though there is the National Conference of Standards Laboratories as well as many private testing organizations. In this sense the NBS is at a disadvantage, which as I see it makes the initiation of this Seminar all the more commendable.

The execution of very high precision measurement costs roughly the same whether it is done in Gaithersburg, Jerusalem, or Accra. However, as the GNP of Israel or Ghana is between 1% and 0.1% that of the USA, it means that relatively speaking such measurements in the less developed countries are 100 or 1000 times more expensive. We therefore take it as axiomatic at this stage of the discussion that such high precision measurements should not be carried out in the less developed and smaller countries. As Dr. Astin pointed out, there are probably ten high precision national laboratories in the world. That is all that is needed.

In applying system analysis to our own situation in Israel we determined that it would be far cheaper for us to have primary or even secondary standards and etalons calibrated at the NPL or the NBS than to do it ourselves, and that one of the useful functions of the Israel NPL should be to act as "postman" for the local companies that might not have the machinery for packaging, exporting, and importing their standards.

My general conclusion, therefore, is that in the area of basic standards and precision calibration, the link should be between the less developed countries and some bodies at a lower level than the NBS, for example, the British Calibration Service, if they will agree. Fortunately, this does not leave the NBS out in the cold, for there are other areas where the technological gap is smaller. Consider for example legal metrology (i.e. weights and measures). In the same way that NBS provides instruction and supervision to the weights and measures offices of the 50 States of the Union, the less developed countries could be granted "honorary membership" in the Union for this purpose. It is probable that the needs and the technological competence of the local personnel of the less developed countries are not very different from those of some of the less developed States of the Union. Thus, one suggestion for what NBS and AID can do is to give the opportunity for personnel from the less developed countries to participate in the courses organized by the NBS for the individual States. Indeed, I can well imagine that NBS has already had such participants from abroad.

In the area of standards-writing and standardizing procedures, I believe that a great deal of assistance could be given by NBS, but as this is not an area of my competence I leave the point to others.

I have mentioned elsewhere the extension of the standard reference materials concept to that of one-shot fixed point calibrated standards to be used in-house in industry. I think this can be an interesting area for research in less developed countries--where the purpose of the research amongst other things is to keep the scientific staff stimulated--but clearly NBS could become involved in this, particularly following the success of the SRM program. (It is an area of activity that could benefit industry in the USA just as much as it might benefit the less developed countries.) I can even conceive of cases where projects could be carried out jointly either in the laboratories at each end or by temporary transfer of staff members. This proposal is virtually identical to that made by Dr. Huntoon earlier this afternoon.

Mr. Russek's paper calling for a systems approach and operation analysis to determine what tests to do and what equipment to set up in a less developed country was in my view most apt for this discussion. However, I am extremely doubtful if in most of the less developed countries you will find either the systems analyst or the calibration expert who are suggested as a team of two to carry out the analysis. I therefore suggest that this would be one area in which NBS and AID could help less developed countries in the metrology field. Presumably NBS could provide the experts and AID the finances to cover the cost of such a team visiting a given country. The savings on inappropriate purchases may more than offset the cost of the analysis team. Treasury officials in the developing countries would probably not accept this thesis in advance, and the scheme in practice would only operate if AID covered the major part of the cost.

Dr. Branscomb:

First, let me say that the NBS would be most pleased to see the British Calibration Service take a vigorous step forward to assist less developed countries. We would not feel left out in the cold at all. We are not looking for work at the expense of the less developed countries. We have plenty of work to do, but if you need our help we would like to figure out whether we are capable of helping. We certainly would like others to help too. Indeed, maybe we could send some of our State officials to the British Calibration Service to learn how to do their jobs better, using as you suggested a reciprocal arrangement.

I would like to take that point of departure to emphasize that because as we advise our own States on the establishment of metrological services, we believe we can help other people establish metrological services. The most valuable feature we have to offer comes from the fact that we are the NBS and not the British Calibration Service. NBS has a deep and active concern for the economic development of the USA through the strength of its useful technology. That is our job; it is not, in my view, simply measurement standards or industrial standards, and we are not as competent as we would like to be in those areas. Although we have only recently acquired our systems analysis capability, that is the direction in which we are going. We will be helpful to you if we simply avoid foisting off on you some set of metrological functions that we may have undertaken in the past, thinking it a legal obligation without understanding what we were trying to do. We are struggling with the question, but I do believe that we might be helpful in a cooperative and collaborative way in institute building--perhaps most of all in the analysis of what kinds of institutional functions are really needed, and in assisting a country to determine for itself what is the appropriate institution in that country to provide those functions. I would hope that our people would contribute a rather strong bias toward a very flexible outlook on the institutional structure. There is the danger that metrological and standardization services if adopted too hastily or administered too rigidly can be a serious impediment to innovation.

I am exceedingly grateful for Dr. Huntoon's remarks because I found them very stimulating. I would like to emphasize something he said. He noted that the traditional metrological laboratory has instruments calibrated externally in order to provide accuracy control. We also have at the NBS a program called the collaborative reference program for certain materials. This is analogous to the external control of the measurement analysis program which deals with the measurement of a physical quantity like voltage, length, or time. We measure an industrially relevant property like gloss on paper by sending standard gloss papers out to industry laboratories. They measure them and send us the data back.

In Dr. Huntoon's description of a measurement quantity for which you chart accuracy in one dimension and range in the other, you recognize that along the abscissa lie values of relatively low accuracy for which self-calibration may be used. Suppose you change the label on such a chart from voltage, current, length, or mass to gloss, hardness, brittleness, or any other industrial property that is important to your product. Suppose you provide, not standard reference materials, but product reference materials in order to fill in the X's on that chart. Then you have a continuous system which includes both the physical measurement and the realization of whether or not you have achieved the quality control implied in an industrial standard for that product.

In this way the two worlds of industrial standards and metrology come together. That leaves one with the obvious thought that if this is a good idea, the standards-writing bodies like ASTM, ANSI, and ISO should give very serious consideration to specifying in the standard more than just the level of performance and a test method calibrated by external control that can be used to realize it. They should try to provide at least an option of quality assurance through a product reference material or standard reference data or some other effective means for self-calibration. I think this is an exciting idea. It clearly has a requirement for adaptation to a local situation, because each country could indeed make its own set of such charts, choosing the accuracies and the range points and the reference materials to suit its own requirements. This is a national service. If the economy of a country rests on a particular commodity or product for which quality control is particularly important, then it should provide a central system for self-evaluation through product reference materials or analogous schemes. It might seek external aid or do it without external aid. The suggestion is worth further pursuit.

Dr. Probine:

I would like to refer very briefly to the afore-mentioned gap between the capabilities of NBS and that of the corresponding institutions in less developed countries. A friend of mine is a very successful designer of household refrigerators and deep-freeze cabinets. So successful is he that New Zealand has been able to export these products overseas and compete with other much more industrialized countries. I asked him once, what was his secret. He said it was careful selection of materials, rationalization of design, selection of production methods which were both efficient and suitable for the country and the use of the KISS principle. I asked him what the KISS principle was. He said, Well, when I am sitting down to design something I keep saying to myself: Keep It Simple, Stupid. The NBS staff taps a great repository of technological virtuosity and I would hope that in planning any program to assist underdeveloped countries, particularly those at a very early stage of industrialization, they will in fact remember to keep it simple.

Dr. LaQue:

One reference by Dr. Brady was to the system for cataloging information, particularly with respect to national and international standards. In recent meetings on the ISO program in this field, there were representatives of a number of nations who have embarked or are about to embark on similar systems of cataloging. The objective is to make all of them compatible with each other so that they can be interconnected. The NBS has been very helpful to ISO in planning their cataloging program, so that I am sure this program will be tied in with the NBS computerized system.

Finally, I note Dr. Tabor's reference to the difficulties of metrology, and I would like to say that if in fact the problems of metrology are more difficult than those of industrial standardization, I offer my most sincere sympathy to the metrologists.

Mrs. LeRoux:

Gentlemen, I just want to thank NBS and AID for the opportunity given to us to sit in this Seminar. I am sure it has served its purpose. Let me thank also all you gentlemen for your patience in listening to our problems and in trying to understand them.

Dr. Ghosh:

On behalf of India, I would like to join Madam in thanking our hosts for the excellent arrangements that have been made.

Mr. Felleke:

When I was commissioned to come here and attend this Seminar, my instructions were to tell what our problems were in order to enlist some assistance in alleviating them. When I say our problems, I am speaking for the United Nations Economic Commission for Africa, the African region, and also for my own Ethiopian Standards Institute. I now have to submit a report to my organization and I hope I will match my problems with the answers that I have been able to obtain here. Let me say at once that we shall want to evaluate any assistance that might be channeled to us, rather than to accept the gift unquestioningly. Any program will have to be rationalized and tailored to our requirements. I hope I have identified my problems clearly, and I certainly want to express the thanks of our people to you who have been kind enough to invite me to attend here.

Dr. Salama:

If you will allow me, on behalf of the secretariat of the Arab Organization for Standardization and Metrology, I would like to express deepest gratitude to both NBS and AID for the invitation which has given me the valuable opportunity to participate in this distinguished forum. We have all enjoyed very much the generous hospitality of our hosts and benefitted both from the constructive discussion and exchange of views during the various sessions, and from the enlightening information about the various capabilities of the NBS. I have personally admired the wise understanding of Dr. Branscomb and his colleagues and have been deeply touched by their sincerity and willingness to render assistance in the spirit of cooperation. I will be happy to convey such personal feelings to the national members of ASMO, with the hope that the encouragement which I have received here will soon be translated into positive actions and fruitful steps.

Dr. Tabor:

Dr. Astin, may I ask you please to sum up this Seminar?

Dr. Astin:

In one sentence, it has been a good and productive Seminar. I have been greatly impressed by the interest shown here and I am sure that there is a lot of material for planning and action both by AID and by NBS. I sense a great diversity of problems, even though there is a common theme of meeting national needs for greater competence in basic standards and their dissemination, in testing, in quality control, in standards development, and so on. One point I would like to make is that while we can help you to acquire increased skills in these areas through training, we cannot in my judgment tell you how to organize to carry them out. Let me call to your attention the great diversity in the organizations for basic metrology and engineering standards which exist among the most highly developed nations of the world. The NBS organization has no exact counterpart in any other nation. It is most closely paralleled perhaps in Germany by the PTB--a result of the fact that NBS patterned itself in its early days after the PTB. However, the organizational structure in Germany, in France, in England, in Japan, and in the USSR differs widely from that of the NBS. The organization and the programs both have evolved to try to meet our national needs and I think each of the developing countries has to evolve in structure to meet its own needs. We can help in training and information which will help you better to plan your organization, help you better to identify the programs and the measurement competences that you need. To develop the test methods most applicable to your local community is fundamentally your job, I think. There is much material here for planning and action on our part, but I think there is also much material for planning and action on your part. I would hope that this Seminar is just a beginning, that you will follow Dr. Brady's suggestion and give these matters further thought, discuss the problems with your colleagues, and continue to send us suggestions as to how we can work better as an international family of nations to reap the benefits of technology more widely for all of us.

Dr. Tabor:

Thank you, Dr. Astin. Now I ask Henry Arnold to close the Seminar.

Mr. Arnold:

I shall be brief, but I cannot let you go without saying that from the AID point of view we certainly have received from the developing countries, from the experts in this country, and from other friends abroad, a great many ideas which we will sift in the formulation of some action programs. In the next sixty days we will be working very hard in making some of these decisions. Experiments do not always turn out as one expects when he starts the experiment. Personally, I was quite down in the dumps yesterday. I did not think we were getting very far with the Seminar at all. Today I feel very good about the answers to the two primary questions which AID has been asking.

I think that Dr. Branscomb and his group have been given some comments and suggestions as to introspection of their own operations which they may find interesting, and perhaps useful. I am sure that we from the USA have, despite our intentions not to do so, given you from the less developed countries a great deal of advice. You may find some of it useful, but most importantly, I think we have opened some channels of communication which, as several people have said, we should all try to keep open.

I want to tell our guests from abroad that we appreciate your filling out that little informal questionnaire. I can give you some quick results. The first question was, is there a major need for a program, and the answer is unanimously "Yes." The second question was, what priorities would you assign to: first, training technical specialists; secondly, indoctrinating managers, planners and financial people; thirdly, assisting in surveys of potential benefits from standards programs in less developed countries; fourth, responding to requests for follow-up technical assistance. I need Dr. Cushen's help to analyze these results accurately, but at a quick pass they come out almost even, although everyone has strong ideas. Finally, on the question as to what kinds of persons should be involved in training programs, there were three categories that were mentioned more often than others--scientists, technologists, and government leaders.

Let me close by expressing my appreciation to Dr. Branscomb and his staff and the alumni of the NBS who have contributed so much to our meeting. I would especially like to thank Steffen Peiser and Henry Mason who have been working so very hard on all the arrangements. I would like to express once more my appreciation to all of our visitors from abroad who have contributed frank comments and exhibited a patience above and beyond the call of duty, and finally to our summarizers who have done such a good job.

TECHNOLOGY TRANSFER WITHIN DEVELOPING AREAS

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It certainly is a pleasure for us at VITA to be asked to speak to this group. VITA has had considerable contact with the National Bureau of Standards through the years, particularly when we have needed some kind of technical information which NBS has been able to provide. We have dealt a great deal with the developing world, although our emphasis now is almost evenly divided between working in developing countries overseas and in developing areas in the United States.

Let me begin by describing some situations which are characteristic, I think, of the scope and the range of the technical assistance VITA has been engaged in very recently. It certainly is not representative of the total range of problems on which we have worked through the years, but will give you some feeling of what we are doing now. I will go through a few of these current situations and then give you some of the background on VITA and some information on the broad programs in which we are presently engaged.

In response to a request from the Ministry of Public Health of Botswana in Southern Africa, a team of chemical engineering professors and students at Rutgers University designs a baby incubator which uses kerosene fuel. It is intended for areas where there is no electricity available. The prototype has been designed and is now being constructed.

A rice expert working in Ceylon travels to New Guinea as a result of a request that came from there to VITA and helps set up a series of farmer workshops in order to introduce rice as a new crop to that area. They will use strains developed in the Philippines at the International Rice Research Institute.

A marine architect is called upon through VITA to respond to a request from the Government of East Pakistan to advise on the construction of fiberglass fishing boats in order to replace those that were lost in the recent storm and flood.

A team of vocational education specialists from the United States spent the last year and probably will spend another year on periodic visits in advising the Government of British Honduras, particularly the Belén Vocational Training Center, on the establishment of trade standards and the improvement of the curricula of the vocational training center itself.

An industrial engineer in the United States suggests appropriate machinery for a rubber tire reclaiming plant in Thailand. A VITA volunteer expert in Washington who has some experience with federal grantsmanship acts as advisor to an organization in this country made up of former youth gangs, to help them obtain federal grants for establishing minority businesses in ghetto areas.

In response to a request from the U. N. Economic Commission for Africa, a team of experts produces model schemes for soap-making industries in several African countries.

These are some examples of the work which VITA is doing with volunteer consultants. Now, what is VITA? VITA was established in 1960 on the initiative of a handful of scientists and engineers, some of whom at that time were associated with the General Electric Company in Schenectady, New York. From that very modest beginning VITA has grown into an organization which today uses about 7,000 technical and professional consultants. They come not only from the fields of technology, but also from the social sciences and education--they are not only Americans, but nationals of 70 different countries, who are called upon by VITA as a result of requests that we receive from overseas and from developing areas of this country. To date, VITA has responded to about 20,000 separate requests for technical and professional assistance. We are currently operating at a level of about 2500 requests a year in international fields, and another 700 or 800 requests a year from areas here in the United States. VITA is unique in the sense that it combines two characteristics which are not uniquely American by any means, but certainly representative of America. One of these is the spirit of volunteerism, the idea of giving your time freely in the support of community benefit; the other is the use of the technology which the United States has developed since its pioneer days.

What we call volunteerism in VITA is a bit different from the traditional reputation that volunteerism has had both here and abroad. We found, for instance, that when we started our domestic program a couple of years ago, people in ghetto areas particularly did not want to have volunteers coming in and doing good. They remembered people who at Christmas-time came around and passed out food baskets and they did not like that kind of volunteer service. While it was a nice gesture and probably did something to salve the consciences of the white middle-class people who were the volunteers, it really did not do very much to improve the economic conditions of the people that they were supposedly helping. But VITA is a very different kind of volunteerism. It is much more in the spirit of the Peace Corps (which it predates); VISTA, another domestic U. S. program (which it also predates); and some others which have been started since VITA began some 11 years ago.

I might describe briefly the process by which we provide technical assistance. As I said before, we receive requests from all over the world. We are a responding organization in the sense that we do not design and field our own projects overseas. We respond to those which are started by other people, be they host country nationals or acting for governments of overseas countries. The initiative may come from institutions operating on a multinational or national basis, or from individuals such as missionaries, Peace Corps, or VISTA volunteers here. Once a request is received at our headquarters, it is logged in and classified as to the kind of assistance required. We make a decision right off on whether we can provide information by mail from our own library, from our own publication series, or from some previously answered problem on which we have worked in the past. If that is the case, we go ahead and send out the information within a few days after the request is received. Most often, however, the request has unique or special characteristics so that we need to go beyond our own in-house technical resources, and this usually involves going to our roster of volunteers. Our roster is cross-indexed; in fact, one of our plans for the coming year is to computerize our roster so that we have much faster access to the various skills represented. We begin by corresponding or telephoning some of our volunteer consultants. Then, in some cases, particularly in our domestic program and increasingly in our international program, a short-term consultant needs to visit the requester and the assistance may begin by helping the requester define his problem better. We sometimes find it necessary to narrow a request down to specific kinds of technical or professional input. In general, we provide assistance on management as well as on hardware technology.

Sometimes the question comes up, particularly when I mention short-term consultants, as to how we differ from a private consulting firm, such as

Stanford Research Institute or A. D. Little. One main difference is that we do not charge anything, although we do try to provide some transportation and living costs for our volunteers when they go overseas, but as far as any normal fees are concerned, we ask our volunteers to waive these. If one works for a large company we try to get the company to continue his salary while he takes a paid leave of absence. If he is self-employed it means a greater sacrifice on his part, because we ask him to take time away from his normal job, and if he is a consultant who normally demands $150 to $200 a day this represents a pretty significant contribution on his part.

The other main difference between our assistance in short-term consulting and that of a private profit-making firm is that we offer not only the man and his expertise but the backup of our whole organization in terms of follow-up in a continuing kind of assistance if that is needed. It may be, for instance, that all our consultant does when he is overseas is to establish the fact that certain other kinds of technical information are required. In that case, he has no financial interest in continuing his own involvement if his expertise is not required beyond that first visit. So he is not in a position of selling himself to the requester, but he may ask VITA to continue providing help by mail or by visits of other consultants with other kinds of expertise.

VITA has probably reached a critical stage for the organization. We began rather modestly, and we still operate at a fairly modest level. Our total budget for both international and domestic operations for 1971 is approximately one million dollars which sum reflects almost exclusively our administrative costs. If you were to put a price tag on the value of the technical assistance which we offer I would imagine that it is probably four or five times that amount. However, there certainly is no question about the need for much more effort in the area of technology transfer. I think we have established that VITA, by involving individuals in development assistance through a private organization, can usefully grow. Our approach can be extended overseas. So our plans for the future are fairly ambitious. What we hope to do in the future is to establish what we call counterpart organizations in developing countries and in the United States. The idea here is to identify people in local areas who have technical and professional skills and who are willing to lend those skills on a volunteer basis, and then to build up a skills bank which can respond to local requests for assistance. We have already begun to do this in Washington, D. C., Boston, Houston, and San Francisco, and in three developing countries, the Philippines, Ceylon, and as of March 1971, in the Dominican Republic. We have plans in the next year or so to expand the counterpart program overseas in three more Latin American countries, in Asia, and possibly even in Africa.

We recognize that when these organizations get started they are probably not going to be self-sufficient, either financially or in terms of the range of skills which they are able to mobilize on a local basis. So, we are prepared to lend them staff assistance and advice in getting started, technical backup to keep them going, and in some cases financial assistance. A good example, I think, is our counterpart organization in the Philippines which has now been operating for two years. It has now about 400 Philippino volunteers who are working on problems at the rate of about 25 a month. Some 10% of those problems they refer to us for help, because they call for skills which are not locally available or, at least, not yet locally identified. In the long range we hope that VITA will become recognized not as an American-based organization, but as an international one, or better yet, as a series of national organizations which are mobilizing technical resources and transferring technology within the developing areas themselves.

A further element in the counterpart program to be encouraged is the use of shared information within a region. Our Philippines counterpart

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is already responding to requests from Thailand, Ceylon, and some other Asian countries and does not even call on us in many areas of expertise, such as rice production. In Latin America we fully expect there will be an exchange of technical expertise between our Latin America counterparts. I think that a good many of the requests that we presently receive in Schenectady represent technological information which is already available in the country from which the request came. The problem is that the requester does not know how to put his finger on it. In many cases we also may not be aware of it right now, but we have a greater chance of helping him obtain that type of information from his own country by fostering the establishment of an organization in his own country in touch with the major sources of local technical information. So this is the direction along which we hope to go, although certainly there will continue to be a need for some kind of coordinating function and technical backup from our own headquarters operation in the United States.

In closing, let me quote from the 17th century English philosopher Thomas Hobbes:"Life is solitary, poor, nasty, brutish, and short." I think all of us here have the obligation of trying to alleviate those intolerable human conditions. VITA is only one approach, but one which I think has a very large role to play, particularly in view of the fact that our own Government is pulling back from direct foreign aid and encouraging the private sector to play a larger role.

Prologue Session Discussion

Chairman: Lewis M. Branscomb

Dr. Branscomb:

I am sure Mr. Dennison would be happy to answer questions or to join in a general discussion.

Mr. Dennison:

I forgot to mention our major publications effort, the Village Technology Handbook. This was printed several years ago under a grant from AID and was distributed by AID in a two-volume edition. Last year we revised it considerably and reissued it in a one-volume edition. I understand that there will be copies available for sale here. I invite you to take a look at it. It aims at village level technology in terms of the basic needs of village life. A large section deals with water-transfer devices, pumps, irrigation devices, and the like. There are plans for village tools to make everything, from building fences to adapting bicycles as power plants, a whole range of things that make use of materials which are likely to be available in most developing areas. This is not a book designed for sophisticated industrial development. We had in mind the rural village with a population of under 5,000 in an underdeveloped country. There are comparable villages here in the USA. VITA is probably the chief source of technical assistance for all the "hippy" communes in the USA. We receive almost daily requests for this book from various communal groups in this country.

Questions from the floor:

Can you indicate when and how the transition of VITA took place from a small group of volunteers with no budget to an organization that has a million dollars to spend? What are the sources of funds, and how do you collect the money?

Mr. Dennison:

Our president would say, "I'm glad you asked that question." VITA took a substantial jump in size around 1964, as a result of several foundation grants which permitted VITA to hire a full-time staff, rather than to depend on local people who came in one or two days a week to type letters and take care of the inquiry service. Another very significant event in VITA's history was in 1969 when we began our domestic work. That is funded by the Office of Economic Opportunity through a no-strings grant to VITA to provide technical assistance to all forms of anti-poverty efforts in this country, not just those sponsored by the government or even by OEO. This was a major condition which VITA placed on receiving government money, and that grant was significant in size in terms of our own programs in the past. We are now beginning to do fund-raising from private sources for the domestic program in the same way that we have done through the years for our international program. We receive about one-third of our total international funds from AID through an annual grant with no strings attached. The other two-thirds comes from several large foundation grants and from a number of private corporations. So right now our international program is mostly privately funded and our domestic program is almost all government funded.

Question:

Have you a policy about requests?

Reply:

If we are convinced that the requester is able to pay for consulting assistance from a commercial enterprise, then we will probably suggest that he do so. Of course, it is very difficult to establish that fact by mail, and we almost always give the person the benefit of the doubt if we are not sure. It is a little easier in our domestic program, where we have telephone contact or face-to-face contact. We have not yet received any request from Mainland China, but we do not have any policies that would preclude it if we felt it was appropriate to development.

Questions:

Do you have medical and legal experts among your wide range of volunteers? How does one become a VITA volunteer?

Mr. Dennison:

The answer to your first question is yes, we do accept requests in both medical and legal fields. Usually the medical fields are those of public health or public health services. In the legal field we have accepted requests from people who essentially needed technical and legal advice in order to win a case. An example is a group which was trying to prevent the construction of a freeway through a particular neighborhood in Boston. We did not testify on their behalf; we simply gave them information which they could use in making their argument.

Comment:

That, of course, suggests that your organization might respond to requests from developing countries to assist them in avoiding development. Has that ever happened? The question is not entirely facetious because I believe that one of the problems in technical assistance is the preservation of social and cultural values which will be impacted by the rapid introduction of technology foreign to the culture. That must surely be a problem, yet one to which most Americans can contribute exceedingly little.

Mr. Dennison:

I am afraid I cannot give you an example of that having happened. It may well be that we have encountered something like that.

The previous question about how one becomes a VITA volunteer is an easy one to answer. We have a resume form which is fairly easy to fill out. I would invite all of you to do so. There is no obligation in becoming a VITA volunteer. You are free to reject for any reason, any assignment which we ask you to undertake. The people in this room have the kind of expertise which we need and which we are constantly seeking. VITA has grown from zero to 7,000 volunteers without a single recruiting campaign. I am sure that we could expand our ranks even more if we were to receive more requests than our volunteers could handle. Most of our new volunteers are added through having learned of VITA and its work, or else as a result of our approaching organizations or individuals to ask for some specific skill which we found we did not have represented on our roster.

Questions:

Apparently, VITA has been in existence for approximately 10 years, and the range of activities in which you are involved is extremely broad. Is it possible to generalize on the basis of experience you have had to date with respect to the kind of expertise in which you have rendered assistance and the kinds of organizations that have requested such assistance? If one eliminates requests from sources in a position to defray the expenses of consultant services, what source of organizations are left in the industrial field?

Mr. Dennison:

There has been a shift through the years, I think, from agricultural requests toward requests related to industrial development. There has also been a shift away from hardware technology as we have done more and more face-to-face consulting on management, marketing, business skills, and social science education training skills.

In the international program we are just beginning to talk to organizations like AID to encourage them to support some of the assignments which we would like to undertake in the industrial field. We are also in touch with some of our friends at UNIDO, particularly Joseph Stepanek, and we hope to be able to provide some industrial consulting services through UNIDO. We already respond to several hundred requests a year which come from the UNIDO Industrial Inquiry Service. We also respond to mail requests from the Organization for Economic Cooperation and Development in Paris, from other UN agencies such as UNDP, and from some of the regional economic commissions such as ECA. We provide short-term consulting services to the Peace Corps, which does provide for transportation and per diem, and we receive some foundation support for covering the travel and per diem expenses of other assignments. So the money for that comes from a variety of sources right now.

Question:

Do you have any relationship with the International Executive Service Corps?

Mr. Dennison:

Yes, we do. In the case of IESC some people have asked us if we overlap at all, and I think in almost every case the answer is no. We help the businessman who probably could not afford even the modest honorarium which IESC volunteers require. IESC, I believe, asks the requesting business to pay something like $50 a day and then IESC covers the transportation and the living expenses, but we usually help people who could not even afford $50 a day. We receive a lot of requests referred to us by IESC country directors overseas and our relationship with them is a very good one.

Question:

What standards do you have for the quality of the technical assistance provided?

Mr. Dennison:

We ask and in fact demand of our volunteers to give the same quality service that they would provide as paid professional consultants, yet we are conscious of the attitude to volunteer help as second rate.

Question:

Do you maintain any overseas staff, and do you have any on-site independent reviews of performance?

Mr. Dennison:

We do not have overseas any paid staff from the USA. If it is in a country where we have established a counterpart organization, then we ask them to perform that role. If we are dealing through a sponsoring institution such as UNDP or UNIDO, we ask that institution to evaluate the quality of the service that we are providing. What we try to do is limit our consulting activities to institutional relationships so that we are not just helping somebody on a one-to-one basis. We want to have a multiplier effect whenever possible. If we act through an institutional program we have a much greater chance of achieving such an effect. Then we also have the advantage of receiving an evaluation of the quality of our service.

Questions:

Have there been any problems of liability? What safeguards do you have? Suppose you have somebody design a bridge and it falls apart. Have there been any instances where there has been a question of liability on account of faulty advice?

Mr. Dennison:

To date there have not. We asked ourselves these questions particularly in regard to our domestic program, because of the very real possibility of someone attempting to sue us for having given advice in a situation which did not turn out just right. It has not happened yet. I do not know what our legal liability in that case would be. Overseas, there has been no instance that I know of where we have been found guilty of giving inappropriate advice that resulted in injury.

We have made some mistakes, one of which I think is characteristic of the earlier days of VITA. It is easy to fool yourself into thinking that you can solve people's problems from your own basement workshop when they may be six or seven thousand miles away. Several of our people were really excited about developing solar cookers for underdeveloped areas, particularly where there is a lot of sunlight throughout the year. One of our VITA volunteers was a UN technician who was going to be stationed in Morocco. He decided to introduce solar cookers to Morocco where there is a shortage of fuel. He worked a year and a half. The venture just did not work out, mainly because the Moroccan women cook their evening meal after sundown. We did not realize that when we launched the program.

Questions:

Have you had any problems with political opposition from recipient countries? Have you had any questions about motivation, as did the Peace Corps?

Mr. Dennison:

Fortunately, no. VITA is the personification of what people in AID these days call a low-profile-presence overseas. Even though we are identified as being largely an operation from the USA, we still are not directly connected with any USA agency overseas and as far as I know we have no background which has given us a black eye in any particular area, as did the Asia Foundation which at one point was receiving CIA money. One test occurred fairly recently in Ceylon. I was there about a year ago. Our group which had just formed itself in Ceylon was not at all sure whether they would continue functioning after the elections, especially if Mrs. Bandaranaike won; which she did. As it turned out, several of the people who were elected to our board of directors in Ceylon are now in prominent positions in the new government. Our group in Ceylon is on even better footing officially than it was before, because it was recognized as primarily a Ceylonese operation. It was local people who were working together on local problems. As long as we continue organizing on that basis, we expect no major difficulty.

Question:

Are you able to respond to all the requests you receive?

Mr. Dennison:

There are really two answers to that question. One is that there are obviously a lot of things which VITA is not equipped to respond to in an effective way. We cannot, for instance, field a volunteer for a long period of time, unless we find that rare individual who is himself independently wealthy and wants to devote a piece of his life to volunteer service. For the most part, the kind of people who are on our roster cannot leave their homes for more than two or three weeks or at most a month. If a continuing input from a man on the spot is required we simply cannot respond. However, to long-term programs which need technical assistance from VITA on a periodic basis, either from the same volunteer or from a series of volunteers with different skills appropriate for each step, we can generally respond, and do so very effectively. This is what we are doing for the Belize Vocational Training Center in British Honduras. Our volunteers are down there every three or four months for a couple of weeks at a time. They have been going for over a year and probably will continue to do so for at least another year. Incidentally, this is also the case for the baby incubator for the government of Botswana. The project is part of Botswana's five-year plan in their Ministry of Public Health. It has already taken us about eight months and will probably stretch out in the testing and field application stages for another couple of years. In this way, VITA as an organization can stay involved on a continuing basis.

Comment:

I am curious about your measures of success, the criteria you use, and the impact you achieve.

Mr. Dennison:

Well, let me admit our measurement techniques, especially in our international program, are very crude. The only regular feedback that we get is a form which we send out to the requester which is returned to us in about 20% of the cases. They do not provide very useful information. Almost anybody who receives something free is going to be grateful, yet gratitude is often the only expression recorded. That does not really tell us whether the information we gave the person was appropriate and whether it really had an impact. We do occasionally receive much more detailed information. Our own volunteers who travel overseas for business or pleasure check with us frequently. We tell them about the problems on which we would like follow-up information. We get some feedback that way, or we receive it through people such as Peace Corps volunteers, missionaries, or UN personnel.

Our USA program has been a little easier to handle because we can send out researchers to talk to requesters. Then we really learn whether we had any impact, particularly in the cases where one can measure economic impact. We have a study that was completed last fall on a USA program in which we have actually been able to point to jobs that we have helped create; people have been moved off the welfare rolls; and we could compute savings in tax dollars.

Question:

You said that many of the requests for assistance came to VITA from organizations like UNIDO. Were those requests made directly from UNIDO or did UNIDO refer them to you?

Mr. Dennison:

With UNIDO inquiries what usually happens is that people write to the Industrial Inquiry Service of UNIDO; UNIDO then decides where they are most likely to receive the appropriate information. Perhaps VITA just happens to be the major source of that information within the USA. So UNIDO forwards the request to us, and then we correspond directly with the original requester. That is usually the first time he becomes aware that there is an organization called VITA.

Question:

How do you make the organization known to people in foreign countries?

Mr. Dennison:

Word of mouth accomplishes a lot. We have a newsletter which we send out to all our volunteers around the world. Periodically, we also put out information about VITA, and tell how people can make a request through the embassies of the USA in various countries around the world. Private organizations such as CARE and various missionary services often mention VITA in their own publications.

Question:

Since you do deal in industrial matters and there are a very large number of Americans overseas engaged in business activities, do you ever call upon them to serve as your volunteers and, if so, what do you do about the possible appearance of conflict of interest on their part?

Mr. Dennison:

If we know that there is an American overseas who has the skill we are looking for, and he happens to be nearer to the requester than someone here in the USA, we would probably call on him. If there is a possible conflict of interest, it is usually one which is against his interest and therefore we usually rely on his judgment to make that decision. A request for example came in this last year from Korea in regard to processing canned peas. It happened that we referred the requester to the Green Giant Company, who were in direct competition with the company which initiated the request. So the Green Giant Company simply declined to respond. I think the greatest potential difficulty arises from offers of assistance to a requester who could have paid for it. We could receive a letter from a consultant in the country from which the request came, accusing us of trying to cut in on his legitimate business.

Dr. Rohatgi:

My feeling is that for really effective use of VITA there will have to be counterpart organizations in each of the countries who are working with you. I might mention that a group of students at the State University of New York found that there were a number of people in this country who were interested in the economic development in India, so they formed an organization called the Front for Rapid Economic Advancement of India (FREAI). It had to learn that it needed chapters within India before progress could be made. I do work with FREAI. If there are any people in the audience who want to volunteer for FREAI I would be very happy to pass on their names. Collaboration between your VITA and others like FREAI could really create an effective international network of volunteers.

Mr. Dennison:

I appreciate your comment because I could not agree with you more. That is certainly the direction in which we have to move, not only because it will help to get the word out about the kind of help that VITA can give but also because it will mean sharing the burden of technology transfer with the developing world. I do not think that we or anybody else should be fostering a continuing dependence upon the highly developed world for technology which is in a large part probably already available in less developed contries. Incidentally, we have worked with a number of people who are associated with FREAI, and the organization has been mentioned to me many times.

Question:

Do you attempt to manage entire projects?

Mr. Dennison:

Most of our work is in specific technical inputs to a larger effort, not in managing the entire effort. When we are involved in medium or large scale industrial development it is not in any kind of total project management. It would be in response to a specific technical need, say locating sources of equipment for the canning industry, or providing accounting assistance or plant layout or something quite specific. On a somewhat smaller scale we may act as intermediaries. Recently on a request from Vietnam, we went to the U.S. Department of Agriculture and conned them into designing a duck-processing plant for killing the ducks, cleaning, storing, packaging, and marketing them. The work was done by the Department of Agriculture. The plans were referred to us and we sent them on to Vietnam.

Question:

You were speaking of a vocational school in Belize to which you have different people going for a few weeks at a time. Is there any contact between these people? How do they find out what has been done by their predecessors?

Mr. Dennison:

In the case of Belize, it has been the same people each time; when we have to switch people we have to be sure that the experience gained is shared.

Questions:

Has the Village Technology Handbook been translated into appropriate languages? Should it not be translated into as many languages spoken in underdeveloped countries as possible?

Mr. Dennison:

We are now in contact with ARTAC in Mexico City, a regional translating and printing facility sponsored by AID, in order to translate this edition into Spanish. We hope also to make it available in Portuguese, and French eventually. I think that probably the book is of more use to an intermediary, say a UN technician, than to a farmer in an Indian village.

Comment:

It would seem that probably the next logical step would be to develop a self-help type of book in local languages so that the farmer can read it himself. This could be published by some international organization.

Mr. Dennison:

I think this is one of the things that the counterpart concept would handle perfectly. I think it would be presumptuous for us here in the USA to develop a self-help manual for use in any particular country; but a counterpart organization using local technical people with local experience could do a very good job of producing just such a publication.

Question:

I understand that the current interest in technical assistance programs, particularly those under multilateral auspices, is to establish some sort of priority with respect to the virtually endless technical assistance requests that could conceivably come. Under UNDP and UNIDO auspices there is an effort going on now to emphasize those things which might be of most strategic importance. Is there any thought being given in your organization to the establishment of priorities?

Mr. Dennison:

Our priorities in a sense are established by those organizations with which we deal. To the extent that there is some commonalty among development organizations in priorities, we simply follow through on those goals. We have made an effort to increase our capability in the area of industrial development of small business, but that is really the only trend we have established as a kind of priority.

Mr. Lovejoy:

To clarify the status of UNDP, let me say that the UN has two main funding agencies, the World Bank and the UN Development Program. The actual aid programs are carried out by the technical agencies of the UN including the UN Industrial Development Organization, UNIDO, and about 15 others. UNIDO may be of prime interest at this Seminar, but one must not omit UNESCO which has the jurisdiction for some kinds of standards, metrology, and so on. The UN itself is primarily a political body, but through the Economic and Social Affairs Council it acts as a technical arm in certain fields, namely natural resources and transportation.

About priorities, it is true that UNDP is now going over to what is called a country programming basis, in which the country itself will identify over a period of five years its own internal priorities which can be satisfied by UN aid. This arrangement is very different from identifying priorities in technical aid in terms of industry or agriculture, or public health, or education. In the new setup due to become operational in the next two or three months, we will have a policy planning staff which however is still budgeted on a very small scale. I think you can safely say that the programming, as we call it, is little more than an identification by individual countries of things that they think that the UN can do for them in the next five years.

APPENDIX 2

RESPONSES TO NBS/AID QUESTIONNAIRE BY SEMINAR PARTICIPANTS ASSOCIATED WITH ORGANIZATIONS ABROAD

To help NBS and AID evaluate the results of the Industrialization Seminar and chart the future course of the program, the participants were requested to answer a few questions regarding the nature of assistance in metrology and standardization they would like to be considered for incorporation in the program. Below are stated the questions asked, together with the responses submitted by the participants. (Responses are arranged alphabetically by country, followed by those from international organizations.)

Question 1. Is there a major need for an NBS/AID program with the less developed countries?

Geraldo N. S. Maia - Brazil:

Yes. An NBS/AID program could be of help to Brazil in the area of standardization. Such a program should include:

(a) Selling the idea of the need and advantages of a system of norms, standards and certification that really works, to government high officials, industry and financial leaders.

(b) A system such as this should provide the following functions:

-- To produce the norms for the different materials, parts, products and services including performance standards and test methods. The existing association (ABNT) should be used for this purpose, but it should be upgraded greatly. It should work in a more professional way, with a competent staff of full-time standards engineers. This association should concentrate on the production of norms; it is a giant job if the backlog is to be overcome in a reasonable time. This staff should do the drafts, leaving discussion and approval to the committee members. It needs funding from government, as associates' fees will never reach the needed level.

-- To offer the basic standards capabilities, including calibration of instruments. We have the INPM (Instituto Nacional de Peros e Medidas) but it needs to be greatly upgraded.

-- To offer certification of compliance service. This should include a certification office (federal) and a network of testing laboratories. These laboratories can be either private or official. Some of the existing laboratories can be used if upgraded in some special areas; some new specialized laboratories will have to be created.

It looks to me that it is important to have a system approach to the problem; it is important also that the coordinator of the system be a high federal officer (just one rank below a ministry), so that he can assure the needed leadership, also the use of the system by government itself which is a large consumer. The system should be funded mainly in two ways: federal government money and revenues of certification services.

Zawdu Felleke - Ethiopia:

There is no doubt in my mind as well as in the minds of those organizations whom I represent in this Seminar that the developing countries do have major and very significant needs for NBS/AID action programs concerning standardization and metrology.

Emmanuel Lartey - Ghana:

Yes.

J. Joaquin Bayer S. - ICAITI, Guatemala:

It is a pleasure to answer questions presented about the Industrialization Seminar, including some additional ideas which I think are important for the Central American area.

A well planned program between NBS/AID and the less developed countries should be of a great value for such countries because of their need for much technological and financial assistance in their several programs in standardization, quality control, metrology and research.

A. N. Ghosh - India:

I will speak in favor of help for standardization directly and for metrology indirectly:

(i) For establishment of standards-engineers training institute currently under consideration by UN/UNIDO/UNDP. This will be needed in case UN project fails to materialize.

(ii) For calibration services for engineering measurement hardware like gauges, etc. A large number of centers for servicing the industry will be urgently needed. (On this subject I shall write to you in detail after I have consulted the NPL and Director of Weights and Measures at home.)

Pradeep K. Rohatgi - India:

Yes, very much.

H. K. Work - Iran:

Yes, include National Technical Information Service for elemental technology.

Inyong Ham - Korea:

Yes.

Mahmoud Salama - League of Arab States:

Needless to say, yes. Member countries of the Arab Organization for Standardization (January 1971) are Jordan, Sudan, Iraq, Saudi Arabia, Syria, Libya, United Arab Republic, Kuwait, Lebanon, Morocco, AB Dhabi.

Mervyn C. Probine - New Zealand:

Undoubtedly there is such a need. Countries within my own experience which could benefit greatly are Indonesia, Thailand, and the Philippines. This is not meant to exclude other countries--but in the countries mentioned the need is very great. Malaysia could also benefit from help, but the need is less pressing.

I believe that in order to help a country adequately one must understand the social environment in which aid recommendations will be implemented. For example, Indonesia and the Philippines have very poorly organized government services. Helping them, it seems to me, is a very different problem from helping a country like Singapore which has a good civil service and where the government can exercise a high degree of social discipline.

Metrology services are a means to an end--not an end in themselves. The services one organizes should be designed to meet a real need in the country. I seem to be speaking as an expert, but my total experience in this field is a three-week tour of Southeast Asia. This helps put what I have said in perspective.

Susana Le Roux C. - Peru:

Yes, there is a major need for an NBS/AID program with the less developed countries.

Phi Minh Tam - Vietnam:

Yes. The programs through which NBS/AID can channel technical assistance to developing countries need be developed or strengthened. I believe that the transfer of technology can be best achieved with the establishment and sound operation of national standards bodies.

Ismael Escobar - Inter-American Bank:

Yes.

Derek Lovejoy - United Nations Development Program:

Yes; see details under question 2.

Edward U. Condon - UNIDO:

Yes, unquestionably. The needs are so great that all possible should be done. I would strongly urge that such a program be carried out in close coordination with UNIDO, UNESCO, or other appropriate UN agency. This is important not only because the UN is good in itself, but it is also symbolic and our presence or absence is noted by all. At UNIDO I learned that Moscow runs a special school for training people through UNIDO channels in the field of industry information sources. My comment does not preclude USA having a direct program of its own but this ought not to be done at the price of neglecting UN cooperation.

I am keenly interested in furthering the kind of activity represented by the Seminar and would be willing to devote some time to assisting further developments along this line.

Question 2. What type of program would you consider of high priority for the country (or countries) of principal interest to you such as:

(a) training technical specialists from the developing countries;

(b) indoctrinating managers, planners, and financial people responsible for developing the standards infrastructure;

(c) assisting in surveys of potential benefits from standards programs in developing countries;

(d) responding to requests for follow-on technical assistance, including possible participation in adaptive or operational research to identify and prove out locally suitable methods?

Geraldo N. S. Maia - Brazil:

Training programs would be very important; I believe that the order of priority is:

(a) indoctrination of managers, planners and financial people (official and private) that should have interest or responsibility for standards infrastructure.

(b) training technical specialists for production of norms, performance of tests, maintenance of standards and calibration of instruments.

Zawdu Felleke - Ethiopia:

The following are priority areas of interest to me and to other less developed countries of the African region requiring urgent technical assistance programs:

(a) training of standards engineers, scientists and local technical staff engaged in metrology work, in particular, in legal metrology activity

(b) assistance in establishing physical requirements for

(i) libraries and office premises,
(ii) testing facilities and physical laboratories, and
(iii) District Control Laboratories and Official Inspectorates for legal metrology work

(c) responding to requests concerning the follow-up of technical assistance, including active participation in operational research to identify and prove out locally suitable methods.

Emmanuel Lartey - Ghana:

Specific projects in (a) and (d); omit (b) and (c):

(i) Metrology:

NBS to assist the Institute of Standards and Industrial Research in establishing an "Instrument Calibration Unit" for Ghana.

(ii) Industrial Research:

NBS to assist above Institute by providing technologists in the fields of metallurgical engineering, ceramics and petrochemical engineering.

(iii) Standardization:

NBS to assist the National Standards Board of Ghana by providing technologists for quality control on leather and rubber.

J. Joaquin Bayer S. - ICAITI, Guatemala:

Priorities for the developing countries:

(i) training technical specialists for the developing countries in such fields as: standardization, metrology, quality control and research,

(ii) promotion of these services in each one of the countries, indoctrinating managers, planners, and financial people responsible for developing the standards and metrology infrastructure,

(iii) assistance in surveys of potential benefits from standards programs in the developing countries,

(iv) setting up a metrology laboratory for the Central American region, for verification and calibration of weights, volumes, and measuring instruments used by technical and research entities, commerce and industry,

(v) to find sources of financing to maintain the organization for elaboration of standards, as well as the metrology and quality control laboratories, and

(vi) responding to requests for follow-on technical assistance, including possible participation in adaptive or operational research to identify and prove out locally suitable methods.

A. N. Ghosh - India:

(a) top priority.

(b) low priority to India, but higher for developing countries of ECAFE.

(c) need to convince top policy makers about need for support for standards activity and industry establishment of NBS.

(d) I would suggest fruitful exchange not only of trainees from developing countries (including India) to USA (NBS or elsewhere in companies having strong standards activity), but also of experts from India to USA and vice versa on a mutual basis.

Pradeep K. Rohatgi - India:

To question 2, I would assign priority to help in setting up instrument manufacturing companies in developing countries; after that to:

(b) managers, students

(a) technical specialists

(d) follow-on assistance

(c) benefit surveys.

In addition to direct help as listed above, I feel the NBS/AID programs can help greatly in overcoming the psychological barriers and in increasing awareness of metrology and standardization. The help of NBS/AID in demonstrating the catastrophic effects of lack of standardization--such as failure of bridges or the burning of houses because the couplings did not match, or in showing the economic benefits of standardization, would have a big impact. NBS/AID should earmark help to universities specifically for setting up standardization and metrology laboratories, developing courses in these areas, and developing cheap textbooks in these areas. The children, the students and the managers of industry should be exposed to the importance of precision, standardization and quality control.

H. K. Work - Iran:

(a) technical specialists

(c) informal ratings of progress

Inyong Ham - Korea:

Depends upon specific needs; for Korea, (a) and (d).

Mahmoud Salama - League of Arab States:

For the members of ASMO, (a), (c), and (d).

Mervyn C. Probine - New Zealand:

(a) I believe that the best help is "on the spot" help over an extended period. The kind of aid where the donor "sticks $100,000 under the door and goes fishing" is not very useful. Nor is the occasional flying visit of a technical expert. The long term effort in Thailand leading to the setting up of the Applied Scientific Research Corporation of Thailand in Bangkok is an example of the best type of aid. The organization can evolve slowly with the needs of the country; people who will ultimately take over can be adequately trained and the experts can guide the program with a good knowledge of what is really needed.

The Instrument Repair and Calibration Centers set up in a number of countries are playing a valuable role in the field covered by this Seminar; and NBS/AID could do a lot worse than strengthen these existing centers. Strengthening these centers might involve:

(i) Making available suitable equipment.

(ii) Training staff in procedures and use of this equipment. This would include training people in bench skills such as instrument making, glass blowing, tool making, etc., as well as in measurement.

(iii) Key staff might be brought to NBS for special training--care must be taken, however, to ensure that such people do not spend long periods in the USA--so that they do not become dissatisfied with life in their own countries.

Some institutions (for example, in Indonesia) have completely inadequate funds available for "maintenance." In one institution in Indonesia with a staff of 25 people, the funds available for maintenance amount to only $100 USA per year. In these circumstances it is impossible to meet the cost of transporting instruments to foreign countries for recalibration--even if the recalibration is carried out by the foreign laboratory free of charge. In these circumstances the full cost of recalibration, from laboratory back to laboratory, may have to be met from US/AID funds.

Very few laboratories in Asia engaged in calibration work are adequately housed, in the sense of having adequate temperature and humidity control, vibration-free mountings, dust-free atmosphere, good electrical supply, etc. Some assistance with the provision of suitable housing for this type of activity could be very useful.

(b) The various countries I have visited have widely different problems --but one thing which they seem to lack in common is good scientific management (obviously there are some institutions which are an exception). I believe therefore that a useful job can be done in giving some training to senior scientists, engaged in administration, in the principles of administration. The principles on which such people should be selected might include:

(i) Very careful selection of the person to be trained based on personal knowledge of his personality and ability--not selection because of his administrative position.

(ii) Although it might appear to be inconsistent with (i) above, one should as far as is possible select people next in line for the top job--subject to fulfilling the requirements of personality and ability.

By training in administration I do not suggest a very advanced course such as one might receive at the Harvard Business School; but simple training in management, communication, organization, planning and control, financial control, etc. The principle behind this suggestion is that it is better to train people to manage their own affairs than to do the job for them.

(c) Assisting in surveys of facilities would be useful in revealing gaps in coverage. Surveys of potential benefits would be more difficult--I am personally uncertain about the benefit of such surveys unless they are done by people who really understand the country.

(d) Follow-on technical assistance is absolutely vital. I believe I made this clear in the answer to question 1. I do not know what the second part of (d) means--but if it covers the type of thing suggested by Dr. Tabor (see Paper 3.3) I agree.

Susana Le Roux C. - Peru:

First priority should be (d): Responding to request for following-on technical assistance, including possible participation in adaptive or operational research to identify and prove out locally suitable methods. Nevertheless, the programs, (c), (b), (a) in that order, are very important too and would be of great interest.

Phi Minh Tam - Vietnam:

For Vietnam, the program should involve all the points mentioned in this order: (b), (c), (a), and (d).

Ismael Escobar - Inter-American Bank:

For Latin America, I suggest the order (b), (a), (d), (c).

Derek Lovejoy - United Nations Development Program:

I believe that NBS could be of assistance in the following areas:

(i) Telephoned inquiries on specific technical problems,

(ii) Providing consultants for missions of 2 or 3 weeks duration in connection with project appraisal, design, and evaluation,

(iii) Working through the UN technical agencies which execute projects, in provision of experts for missions of 1 month to 2 years, and placing of trainees at NBS,

(iv) Possibly, in conjunction with UN technical agencies, arranging seminars, or speakers for seminars.

Programs 2(b), 2(c), and 2(d) may be of interest particularly in more

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sophisticated countries, and might at the present time more easily be funded through USAID than through UNDP.

By way of explanation on these comments, my responsibilities at UNDP cover project request appraisal, project design, and subsequent project evaluation (to the extent which somewhat limited resources makes possible) in the broad field of assistance to institutions in the physical and engineering fields. These activities are carried out in collaboration with the requesting governments and the relevant UN technical agencies (UNIDO, UNESCO, etc.) and in many cases with outside consultants.

Specifically, and related to NBS interests, I have covered in the last four years some 50 projects on requests in 30 countries involving:

(i) Standards testing
(ii) Metrology centers
(iii) Industrial research institutes
(iv) Instrument repair, design, and calibration centers
(v) Textile technology institutes
(vi) Metalworking industry institutes
(vii) Building materials institutes
(viii) High voltage testing facilities, and in addition another 50 or so projects in a variety of scientific and technological fields including air and water pollution, desalination, and computer applications.

Edward U. Condon - UNIDO:

All of the things listed under 2 are being undertaken by UNIDO with inadequate resources. I would like to see the NBS/AID program start by working with UNIDO, especially the part headed by Dr. Joseph Stepanek, who is already quite aware of specific needs. My personal interest runs more to (a) and (d). I think (c) is not needed, in the sense that the benefits are so clear that further study of benefits is not essential; the job is to go at once to the actual development of a standards infrastructure.

As to (a) I think the training should be done largely by developing regional training institutes instead of bringing the trainees here to America. The advanced trainees who are already professionally placed could be brought to America, but the initial trainees should get their training nearer home. With regard to (d) we want to make sure that the technical assistance is given with regard to appropriate technologies, rather than merely trying to spread American practice which is not always appropriate to the conditions in LDC's.

There are great opportunities available to us to assist in the founding of a world chain of standards and metrology training institutes by proper utilization of surplus military property overseas, both as real property in bases whose military use is being discontinued, but also in the vast amount of machine tools and electronic servicing equipment which is overseas, and which it will not be worthwhile to ship back home. These bases also have medical equipment which could be of great value for training schools in health techniques. I would suppose that the Department of Defense would welcome arrangements for effective AID use of these properties when they no longer have a military role to play. It ought to be possible for these to be turned over by DOD to AID or IDI for use in technical aid programs of the kind here being discussed.

Question 3. What kinds of persons should be involved in training, exchange, demonstration or working visits to NBS - scientists, technologists, technicians, entrepreneurs, business men, economists, government leaders, or financiers?

Geraldo N. S. Maia - Brazil:

I believe that the only program of visits to NBS that would be of use is for managers, planners and financial people.

Zawdu Felleke - Ethiopia:

As far as training and exchange of staff are concerned, the following are suggested to serve as guidelines:

(a) Providing or making available NBS scientists and experts as advisors in the standardization and metrology work and efforts of the developing countries.

(b) Providing exchange programs between NBS scientists and those in the developing countries engaged in standardization and metrology work.

(c) Providing fellowships to technologists and technicians of developing countries engaged in standardization and metrology activities.

Emmanuel Lartey - Ghana:

Technologists, scientists, technicians, economists.

J. Joaquin Bayer S. - ICAITI, Guatemala:

The persons involved in the program should be scientists, technologists, technicians and government leaders, preferably with a background in engineering, chemistry or physics.

A. N. Ghosh - India:

Scientists and engineers engaged in weights and measures departments of NBS or states. Sometimes government leaders from developing countries for short term indoctrination to U.S.

Pradeep K. Rohatgi - India:

Involve technologists, entrepreneurs, business men, government leaders, technology educators. The U.S. Department of Commerce should set up U.S. patent libraries (containing listing of U.S. patents, with a few examples of actual patents) at the universities to stimulate students to innovate. Patents, more than technical papers, contain innovations and the awareness of innovation in the form of patents is greatly lacking among engineering students in developing countries.

H. K. Work - Iran:

Scientists and technologists.

Inyong Ham - Korea:

All of them would be benefited, depending upon the needs, status of development, etc. in the country. For Korea, NBS made a specific recommendation in regard to ROK National Standard Institute in 1968. (See the 1970 report submitted by Mr. Peiser.) This item will be one of the agenda of the meeting between Secretary of Commerce (USA) and Minister of Commerce and Industry (ROK) at the end of February in Washington, D. C.

Mahmoud Salama - League of Arab States:

Scientists, technologists, technicians, government leaders.

Mervyn C. Probine - New Zealand:

Without wishing to appear rude, I think that the USA labors under something of a disadvantage in assisting less developed countries. While the financial and technological resources of this country are superb, its technological virtuosity may blind it to the simpler requirements of many of the very underdeveloped countries. In selecting people to help in this area, it is therefore extremely important to use those people who well and truly have their feet on the ground.

Without wishing to give the impression of believing I know it all--I would like to suggest that the principle be KEEP IT SIMPLE! With this in mind I believe that technologists and technicians can play a valuable role--at least in the initial stages of development. Later, as the country develops, much more sophisticated help can be given by a very wide variety of people--such as was given by the Battelle Memorial Institute to the Korean Institute of Science and Technology. Incidentally the sister institute arrangement which was adopted in this latter case could be a useful pattern for NBS to follow.

Susana Le Roux C. - Peru:

Technologists, scientists, technicians and government leaders primarily, but I think that you could also organize visits for people in different groups.

Phi Minh Tam - Vietnam:

It is difficult to specify special persons for training because all are involved in the working of standards. However, a choice can probably be made in this order: government leaders, scientists, and technicians. I mention government leaders in the first instance because they have to be convinced of the benefits of standardization; they have to make the decisions before any standardization programs can be implemented successfully.

Ismael Escobar - Inter-American Bank

Top scientists and engineers.

Edward U. Condon - UNIDO:

I would suppose NBS would pretty much confine itself to working with scientists, technologists, and technicians although the total UN and USA programs need to cover the latter categories in the list.

APPENDIX 3

THE ETHIOPIAN STANDARDS INSTITUTION (ESI):

ITS TASKS AND AREAS FOR TECHNICAL ASSISTANCE

Zawdu Felleke
Acting General Manager ESI
Addis Ababa

1. Introduction

Industrial development is a very recent factor in Ethiopia's national economy but is rapidly increasing in importance. While industry represents only a small percentage of the gross domestic product, it is growing at the rate of 13 percent per annum and is one of the fastest developing sectors of the country's economy. Moreover, Ethiopia's foreign trade -- exports and imports -- also constitute an important activity in order to meet foreign exchange requirements and, consequently, properly steer the development programs of the country. The need for the development of a centralized system of standards is therefore clearly apparent. The existence of standards governing the different commodities and services produced and transacted in the country would be of prime importance to promote production as well as domestic and foreign trade. Hence, the preliminary discussion in this direction was held in 1963 and the first attempt to prepare the legal basis for standardization in Ethiopia was made in 1964. It was not, however, until 14 July of 1970 that the Draft Order which provides for the establishment of the ESI was adopted by the Council of Ministers. Finally, upon approval by His Imperial Majesty, the Order was published in the Negarit Gazeta on 29 September of 1970. Thus, the legal basis which provides for the establishment of the ESI has been created. Besides its basic function of preparing and publishing compulsory as well as optional standards relating to practices, processes, materials, products, and commodities; and of enforcing the same, the ESI has also other important functions such as promoting standardization and quality control in the Empire, developing and implementing the Standards Mark, and establishing cooperation with other national, regional, and international standards bodies.

2. Present Activities

Standards Activities

The following are the different documents which have been prepared by the ESI Secretariat and discussed and approved to date by the Standards Board, which is the governing organ of the Institution:

(i) Paper on "Basic Concepts of Standardization, Its Aims, Benefits and Recent Developments"

(ii) Rules of Procedure Concerning the Work of the Standards Board

(iii) Duties and Functions of the ESI and Its Organizational Set-up

(iv) Rules on the Working Procedure of the ESI in Preparing and Publishing Ethiopian Standards (ES)

(v) Rules on the Establishment and Working Procedure of Technical Committees(TC)

(vi) Guide for the Presentation and Formulation of ES

(vii) Rules on System of Classifying and Numbering ES.

The ESI Secretariat has also prepared and submitted for approval of the Standards Board the following Draft Regulations and other documents:

(viii) Ethiopian Standards Publication Regulations

(ix) Standards Mark Regulations

(x) Principal Working Fields and General Programme of Work

(xi) Programme of Work 1970/71

(xii) Administrative Manual.

Moreover, the first set of standard proposals have been prepared in the three priority fields of basic standards, agriculture, and building materials. These standard proposals will be shortly submitted for discussion by the relevant Technical Committees.

3. Metrological Activities

By a Proclamation enacted in 1963, the metric system of weights and measures was officially introduced in Ethiopia. In 1967, particular Regulations, which provide for the inspection, calibration, verification, and certification of weights, measures, and measuring instruments by the Inspectorate of Weights and Measures created pursuant to said Proclamation of 1963, were promulgated. However, the term "metric" does not unequivocally reflect the relevant units which should belong to the system. It is therefore necessary to prepare a series of Ethiopian Standards based on relevant ISO Recommendations concerning quantities and units of measure. Consequently, the Imperial Ethiopian Government has already made the decision to transfer the activities of the Inspectorate of Weights and Measures to the Ethiopian Standards Institution in order to combine activities concerning standardization and metrology under the ESI.

4. Future Plans

The immediate future plans of the ESI in the field of standardization are as follows:

(i) to prepare and develop standards in other industrial branches such as mechanical, civil, and electrotechnical engineering, chemistry, and textiles, as well as those concerning safety to be embodied in codes of practice,

(ii) to implement the Standards Mark and certify products, materials, and commodities which conform to valid Ethiopian Standards,

(iii) to establish a more active cooperation with the ISO and IEC in fields which are relevant to the country's economic needs.

Immediate plans as regards metrology are:

(i) in the field of legal metrology, to strengthen the central office of the Inspectorate of Weights and Measures and gradually expand its activities concerning inspection, verification, and calibration of weights, measures, and measuring instruments to other regions of the country, outside of Addis Ababa and Asmara,

(ii) to set up a Physical Laboratory and other District Control Laboratories for metrology.

5. Areas for Technical Assistance

Since Ethiopia, like other developing countries, is faced with limited available resources and technical personnel, foreign technical assistance in metrology and standardization work is urgently required. In order to properly operate the new ESI all the essential physical requirements must be provided right from the initial stages. Without going into any extended details, the requirements essential for the ESI in its standardization work consist of:

(i) training of local technical staff engaged in standardization work

(ii) establishment of materials testing facilities

(iii) assistance in constructing office premises for the ESI.

The following are particular areas in which urgent foreign technical assistance is required by the ESI in its efforts concerning metrology work:

(i) provision of an expert in weights and measures

(ii) training of local technical staff engaged in inspection, verification, and calibration of weights, measures, and measuring instruments in the Empire

(iii) provision of reference and working standard instruments and the establishment of a National Physical Laboratory

(iv) assistance in establishing District Control Laboratories for Metrology and Inspectorate Offices.

6. Conclusions

In order to further promote industrial development, which is already rapidly increasing in Ethiopia, the importance of introducing standardization and quality control in the country has been fully recognized. Consequently, ESI has been established as an autonomous and the only official standardizing body in the Empire. The Institution is charged with the task of preparing, publishing, and implementing Ethiopian Standards relating to practices, processes, materials, products, and commodities in the field of commerce and industry. Activities concerning weights and measures have also been transferred to the ESI and, thus, the responsibilities and tasks of the Institution have been expanded to include metrological work. Faced with limited available resources and technical personnel, the ESI has an urgent need for foreign technical assistance in order to enable the proper and efficient execution of its tasks concerning metrology and standardization.

APPENDIX 4

UNESCO QUESTIONNAIRE ON THE FACILITIES FOR BASIC PHYSICAL STANDARDS OF WEIGHTS AND MEASUREMENT (METROLOGY) IN SOUTHEAST ASIA

Introduction

Dr. M. C. Probine, Director of the Physics and Engineering Laboratory of New Zealand's Department of Scientific and Industrial Research, prepared a questionnaire on the "Facilities for Basic Physical Standards of Weights and Measures (Metrology)" in connection with a survey he made for UNESCO on such facilities in the following South East Asian countries: Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand. He also completed the questionnaire for New Zealand, as an example supplied for initial guidance to the countries concerned. The full and most useful information which he received from countries of the South East Asia region was obtained because of the example which Dr. Probine had himself worked out so carefully.

The questionnaire with the New Zealand responses is here reproduced by very generous permission of Dr. Probine. Similar metrological surveys in other regions may be judged desirable and could be patterned on Dr. Probine's UNESCO questionnaire. (For some further comments by Dr. Probine, see discussion on Session 4.)

The Questionnaire as Completed for New Zealand

Country: New Zealand Date: 14 May 70

Completed by: Dr. M. C. Probine

1. NATIONAL STANDARDS OF MEASUREMENT

1.1 DOES THE COUNTRY HAVE A WEIGHTS & MEASURES ACT (OR, ANY OTHER ACT) WHICH ASSIGNS TO ANY INDIVIDUAL, OR BODY, RESPONSIBILITY FOR THE CUSTODY, MAINTENANCE, AND DEVELOPMENT OF NATIONAL STANDARDS OF MEASUREMENT, AND FOR THE PROVISION OF MEANS AND METHODS, OF MAKING MEASUREMENTS CONSISTENT WITH THOSE STANDARDS?

New Zealand's principal Weights and Measures Act dates back to 1925, and bears a fairly close resemblance of that of Great Britain; indeed some of the Sections were lifted from the Weights and Measures Act 1878 (Imperial). Other Sections in the 1925 Act had their counterparts in the legislation of New South Wales and South Africa.

By Section 6 of the 1925 Act, the principle standard measures were regarded as being in the custody of the Minister of Labour. By a 1933 Amendment, the Minister in charge of the Department of Scientific and Industrial Research was to procure copies of the Imperial Standard Pound and Yard, and, on a date to be fixed by him by notice in the Gazette, these copies were to become standard weights and measures in New Zealand. Section 6 of the 1925 Act was then deemed to be repealed.

The Scientific and Industrial Research Amendment Act, 1945, consolidated the situation so far as National Standards were concerned and the Department of Scientific and Industrial Research was charged with the following functions, namely:

(a) to maintain all principal standard measures for the time being in the custody of the Minister;

(b) to compare principal standard measures with corresponding standard measures outside New Zealand by such methods and at such intervals as may from time to time be prescribed by any Act or Regulations or (subject to any such Act or Regulations so far as they do not extend) as may be directed or approved by the Minister;

(c) to compare with principal standard measures, and to certify, such copies thereof and such secondary standard measures or denominations derived therefrom as may from time to time be required.

Power was given to make regulations for all or any of the following purposes:

(a) Describing methods of comparison and certification of copies of the principal standard measures and of standard measures derived from principal standard measures;

(b) Prescribing the nature, form, and derivation of New Zealand standards of measurement, not being standards which are prescribed by or under any other Act or which there is power to prescribe under any other Act.

To summarize, therefore, the responsibility for administering Weights and Measures Legislation as it relates to "Weights and Measures" used in Trade is placed with the Department of Labour. The responsibility for "National Standards of Measurement" is placed with the Minister in Charge of the Department of Scientific and Industrial Research. In practice, the Physical Standards for New Zealand are maintained by the Physics and Engineering Laboratory of the Department of Scientific and Industrial Research.

1.2 IF THERE IS SUCH AN ACT, FROM WHICH YEAR DOES IT DATE, AND IN WHICH YEAR WAS THE LAST REVISION?

See above - 1.1

1.3 ARE THERE ADEQUATE FACILITIES FOR MAINTAINING AND DEVELOPING THE NATIONAL STANDARDS OF MEASUREMENT, AND FOR CARRYING OUT PRECISION MEASUREMENT AND CALIBRATION, TO MEET THE NEEDS OF THE COUNTRY IN THE FOLLOWING AREAS:

1.3.1 SCIENTIFIC INVESTIGATION?
1.3.2 ENGINEERING AND MANUFACTURING?
1.3.3 COMMERCE AND TRADE?
1.3.4 EDUCATION?

In general, the answer to all of these sections is "Yes." Our capability in the field of physical standards and associated calibration fields is continually under review, and, as a general policy, we try to stay ahead of the measurement and calibration needs of the country in all fields. New Zealand is a small country (population 2,800,000) and there is therefore a limit to the resources which can be allocated to this, and, indeed, to any other field of science. So far, however, we have been able to meet the needs of the country; but because N.Z. is developing its industrial capability very rapidly, it is necessary to be constantly improving our facilities.

There are, however, some special areas in which we are weak; for example, in the area of Engineering Metrology there are no facilities for gear measurement. Some improvement in the field of electrical measurements at radio frequencies is also required.

However, New Zealand does not have a well co-ordinated testing and calibration service in the sense that there is no "Laboratory Approval Scheme" in this country to ensure that measurements made in industry are made by qualified staff using recognised procedures, and "working standards", whose calibration can be traced back to the national standards. This matter is under review at the present time; and it is hoped that a scheme similar to the "National Association of Testing Authorities" in Australia, will be set up shortly in New Zealand.

1.4 IF THE ANSWER TO ALL, OR ANY, OF THE SUBSECTIONS IN 1.3 IS "NO", IN WHAT WAY ARE THE FACILITIES CONSIDERED TO BE INADEQUATE?

See above - 1.3

1.5 ARE THERE ANY FIRM PLANS FOR MAKING GOOD DEFICIENCIES WHICH EXIST AT PRESENT?

See above - 1.3

1.6 PLEASE OUTLINE BRIEFLY HOW EACH OF THE PRINCIPAL STANDARD MEASURES IN THE FOLLOWING LIST IS DERIVED (I.E., WHETHER DERIVED:

(a) INDEPENDENTLY,

(b) BY REFERENCE TO A HIGHER QUALITY STANDARD AT ANOTHER NATIONAL LABORATORY: OR AT THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.)

1.6.1 LENGTH
1.6.2 MASS
1.6.3 TIME
1.6.4 CURRENT (OR, ELECTROMOTIVE FORCE AND RESISTANCE)
1.6.5 TEMPERATURE
1.6.6 LUMINOUS INTENSITY

1.6.1: Length

Length can be derived independently by interferometry; but our interferometer is of rather simple design and further improvement here is desirable. Present accuracy is one part in one million, or better. We also have "calibration grade" Slip Gauges which have been calibrated at the National Physical Laboratory in England.

1.6.2: Mass

The primary standard of Mass is the kilogramme. The Laboratory holds three austenitic, non-magnetic stainless steel one-kilogramme weights, the values of which are known to be better than one part in ten millions. These weights are calibrated periodically at the National Physical Laboratory in England.

1.6.3: Time

The responsibility for measurement of time lies with the Geophysics Division of the Department of Scientific and Industrial Research. Frequency is, however, maintained by the Physics and Engineering Laboratory. The maintenance of frequency involves a continuous study of four precision crystal oscillators which collectively constitute the N.Z. National Standard. These are continuously intercompared with overseas standard frequency transmissions by monitoring WWVL, Boulder, U.S.A., and G.B.R., Rugby.

The present best measurement capability is 1 to 2 parts in 10^{10}.

It is hoped to purchase a Caesium Beam Oscillator later this year, and it is anticipated that the best measurement capability will then be 1 to 2 parts in 10^{11}. A Standard Frequency Transmission is made from ZLFS at P.E.L. at a frequency of 2.5 MHz on one afternoon per week.

1.6.4: Current

Current is not derived independently. Voltage is derived by using a group of six standard cells calibrated by the National Physical Laboratory. We believe the accuracy of the volt is ± 1 microvolt (but we claim only ± 3 microvolts). The last intercomparison with N.P.L. was in 1967.

Resistance is derived by using four 1-ohm standard resistances which have been calibrated at the National Physical Laboratory. Two of these are extremely stable having, in past, held their calibration to 1 part in 1 million for 25 years. The accuracy of resistance is believed to be 1 part in 1 million (but we claim only ± 3 parts in 1 million). Plans are in hand to derive resistance from a Thompson/ Lampard type calculable capacitor.

1.6.5: Temperature

The International Practical Temperature Scale of 1968 can be derived independently from 0°C to 630.74°C, by the use of platinum resistance thermometers constructed to conform with the requirements of IPTS-68, and by using the fixed points and procedures laid down. Standard platinum resistance thermometers are also calibrated periodically on our behalf by the National Physical Laboratory in England as a check on our realization of the scale, and to extend our calibration range from 0°C to -182.962°C (Oxygen point). The scale can also be derived independently from 630.74°C to 1064.43°C (Gold point) using approved thermocouple materials and procedures. Above the Gold point the scale is maintained using tungsten ribbon filament lamps up to 3000°C calibrated at the National Physical Laboratory, England.

1.6.6: Luminous Intensity

Luminous Intensity is derived from standard tungsten filament lamps calibrated at the National Physical Laboratory in England. The range of the standards held at present is from 24 to 1400 candelas, with accuracies ranging from ± 0.25% to ± 1.0%

1.7 WHERE, AND HOW OFTEN, ARE THE PRINCIPAL STANDARD MEASURES INTER-COMPARED INTERNATIONALLY?

See 1.6 - above

2. COMMERCE AND TRADE

2.1 IS THERE AN ACT (OR ACTS) TO PROVIDE FOR THE REGULATION, ADMINISTRATION, CONTROL AND USE OF WEIGHTS AND MEASURES USED IN COMMERCE AND TRADE?

Yes - see 1.1 above

2.2 ARE THERE LEGAL SANCTIONS TO MAKE THE ACT (OR ACTS), REFERRED TO IN 2.1, EFFECTIVE?

Yes

2.3 IS THERE AN ORGANISATION OF "WEIGHTS & MEASURES" INSPECTORS TO ENSURE THAT THE PROVISIONS IN THE ACT ARE ADEQUATELY POLICED?

Yes

2.4 ARE THE STANDARD MEASURES USED BY THE "WEIGHTS & MEASURES" INSPECTORS REGULARLY OR PERIODICALLY VERIFIED?

Yes

2.5 IS THERE AN APPROVED SYSTEM OF CHECKING THE STANDARD MEASURES, USED BY WEIGHTS & MEASURES INSPECTORS, AGAINST MEASURES OF HIGHER QUALITY, UP TO THE LEVEL AT WHICH THE HIGHER QUALITY MEASURE IS THE ACCEPTED NATIONAL STANDARD?

Yes. It is true, however, that intercomparisons between the National Standards and the working standards has not been carried out as frequently in the past as is desirable, and this question is receiving attention at present.

2.6 WHAT IS THE PREVAILING SYSTEM OF WEIGHTS & MEASURES IN THE COUNTRY?

Imperial System

2.7 IF THE METRIC SYSTEM IS NOT YET THE OFFICIAL SYSTEM OF WEIGHTS & MEASURES, WHAT IS THE GOVERNMENT'S PROGRAM AND POLICY FOR INTRODUCING IT AND OVER WHAT PERIOD IS IT TO BE INTRODUCED?

On the 29th February 1969, the Minister of Industries and Commerce announced that "Government has accepted in principle that New Zealand will sooner or later adopt the metric system of weights and measures. Government accepts the necessity of assisting metrication in New Zealand, and to this end it accepts the recommendation of Officials that a representative Advisory Board be set up to encourage, assist and advise on the progressive voluntary adoption within New Zealand of the metric system. The process of metric change in Britain is being programmed to be completed by the end of 1975. This will affect New Zealand progressively and should set the pace of change here."

A Metric Advisory Board has now been set up to co-ordinate the change and it is envisaged that the change to the metric system will be largely completed by the end of 1976. 1976 is not a firm inflexible date and some sectors will convert before this date, while in other cases the change will be delayed beyond 1976.

3. INSTITUTIONS FOR BASIC METROLOGY AND ASSOCIATED STANDARDIZATION

3.1 NAME OF INSTITUTION (DEPARTMENT, AGENCY, UNIVERSITY, OR RESEARCH INSTITUTE) FOR WHICH THIS QUESTIONNAIRE IS COMPLETED?

Physics and Engineering Laboratory (P.E.L.)

3.2 ADDRESS (INCLUDING CABLE ADDRESS)?

Private Bag,
Lower Hutt,
New Zealand.

3.3 DATE OF FOUNDING?

1939

3.4 DIRECTOR OF INSTITUTION (ACADEMIC DEGREES, MEMBERSHIP IN SOCIETIES, ETC.)?

Mervyn C. Probine, M.Sc.(N.Z.); Ph.D.(Leeds); F.R.S.N.Z.; F.Inst.P. (London)

3.5 OTHER TITLES AND FUNCTIONS OF DIRECTOR?

No other formal functions.

3.6 IS THE INSTITUTION THE CENTRAL INSTITUTE FOR METROLOGY AND ASSOCIATED STANDARDIZATION IN THE COUNTRY?

Yes

3.7 PRIMARY AIM, OBJECTIVE AND FUNCTIONS OF THE INSTITUTION (PREFERABLY QUOTED FROM ITS CHARTER OR INFORMATION BROCHURE) AS FAR AS STANDARDIZATION ACTIVITIES ARE CONCERNED?

The Laboratory's functions include:-

Basic and applied research in physics and engineering; the statutory function of maintaining national standards of physical quantities such as length, mass, temperature, light, electrical quantities, frequency, etc.; provision of a calibration service for a wide range of physical measuring equipment; introduction and development for new technology suited to New Zealand's requirements and promotion of its effective use in industry; industrial development using the Laboratory's resources of staff and equipment; and maintenance of a workshop giving industry access to specialised machine tools and new machining techniques.

3.8 IS THE INSTITUTION:

(a) A DEPARTMENT OF GOVERNMENT? (IF "YES", WHAT IS THE NAME OF THE DEPARTMENT?)

(b) AUTONOMOUS AND SUPPORTED BY THE GOVERNMENT?

(c) AUTONOMOUS AND NOT SUPPORTED BY THE GOVERNMENT?

A department of Government. Department of Scientific and Industrial Research (D.S.I.R.).

3.9 WHAT IS THE TOTAL ANNUAL BUDGET OF THE INSTITUTION?

$NZ 819,000 (Year Ended 31st March 1969)

3.10 WHAT IS THE ANNUAL BUDGET FOR BASIC METROLOGY AND ASSOCIATED STANDARDIZATION ACTIVITIES?

$NZ 104,000

3.11 WHAT IS THE NUMBER OF STAFF EMPLOYED IN THE FIELD OF BASIC METROLOGY AND ON PRECISION MEASUREMENT AND CALIBRATION?

PROFESSIONAL STAFF	6
TECHNICIANS (SUB-PROFESSIONALS)	11
OFFICE WORK*	3
OTHERS*	3
TOTAL	23

* It is difficult to specify "others", as the Standards staff share workshop, library, stores and general administration with other laboratory groups. The number of Professionals and Technicians listed

is the number employed full-time on "standards" work. Those listed under "office" and "other" are "notional" staff on standards work; i.e. a proportion of the clerical and other staff allocated from total staff on a pro rata basis.

MANAGEMENT, STAFF AND TRAINING

4.1 IS THERE ANY FORM OF TRAINING SCHEME FOR TECHNICAL STAFF?

Technical staff are, in general, recruited as Technical Trainees in the fields of physics and of mechanical engineering. They are regarded as supernumeraries for two years. During this time their practical on-job training is done by a planned system of job-rotation around different sections of the laboratory and, in their second year, around other relevant divisions of D.S.I.R. in the Wellington area.

Concurrent off-job training is provided by attendance at Polytechnic classes for study leading eventually to a N.Z. certificate in Science or in Engineering. Study leave on full pay up to 8 hours per week plus reasonable travelling time is granted.

The annual intake of Technical Trainees is 5, making 10 under training at any given time during the two year training period. The majority of technicians produced by this scheme remain at P.E.L., but some end up as physics technicians in other divisions of D.S.I.R. which are primarily concerned with biology or chemistry.

4.2 IS THE ORGANISATIONAL STRUCTURE OF THE LABORATORY DEFINED AND KNOWN TO ALL CONCERNED (I.E., CHAIN OF COMMAND, AND AREA AND LEVEL OF RESPONSIBILITY)?

Yes

4.3 ARE THERE WRITTEN CALIBRATION PROCEDURES FOR EACH TYPE OF INSTRUMENT TO BE CALIBRATED, AND ARE THEY USED REGULARLY?

No

4.4 ARE COMPLETE CALIBRATION RECORDS KEPT IN A RETRIEVABLE MANNER ON ALL INSTRUMENTS THAT ARE CALIBRATED?

Yes

4.5 ARE THERE COMPLETE CALIBRATION RECORDS FOR THE LABORATORIES' OWN CALIBRATION EQUIPMENT, AND IS THE STATE OF CALIBRATION OF SUCH EQUIPMENT REGULARLY REVIEWED?

Yes

4.6 ARE ALL WORKING STANDARDS AND MEASURING EQUIPMENT RECALIBRATED AT SPECIFIED INTERVALS IN TERMS OF STANDARDS TRACEABLE TO THE PRINCIPAL STANDARD MEASURES (NATIONAL STANDARDS)?

Yes

4.7 WHAT ACCURACY RATIO IS MAINTAINED BETWEEN THE CLIENT'S INSTRUMENT AND THE STANDARD USED FOR CALIBRATING THE CUSTOMER'S INSTRUMENT?

1:4

4.8 DOES THE LABORATORY PROVIDE FOR MAINTENANCE AND/OR REPAIR SERVICES IN CONJUNCTION WITH ITS CALIBRATION EFFORT?

The Laboratory is very well equipped in every way to maintain and repair instruments; but as a matter of policy we do not do repairs on instruments sent in for calibration.

4.9 ARE THERE FACILITIES IN THE COUNTRY FOR TRAINING FELLOWS FROM ABROAD? IF "YES", WHERE ARE THEY LOCATED?

We are happy to train a limited number of people at the Physics and Engineering Laboratory, providing they work on problems in which we have the necessary skill and interest.

4.10 TO WHICH COUNTRIES AND INSTITUTIONS ABROAD ARE FELLOWS SENT FOR SPECIALISED TRAINING IN PRECISION MEASUREMENT AND CALIBRATION TECHNIQUES?

National Physical Laboratory, England.
National Standards Laboratory, Australia.

We also hope to send people to the National Bureau of Standards, U.S.A., in the future.

5. ENVIRONMENT

To assist people answer this section we have set out a number of requirements which we feel are "desirable" for "environmental control" of a standards laboratory. If these can be met it is merely necessary to answer "Yes." If the answer is "No", it would be useful to have an indication of how the control falls short of what is "desirable." (A lower level of environmental control may be satisfactory for some work; but the requirements below should, we feel, be what is aimed at.)

Temperature Control

5.1	TEMPERATURE CONTROL OF GENERAL LABORATORY AREA 20°C ± 1°C?	<u>YES</u>	NO
5.2	MAXIMUM RATES OF CHANGE OF TEMPERATURE LESS THAN 2°C PER HOUR?	<u>YES</u>	NO
5.3	TEMPERATURE OF LABORATORY SPACE CONTINUOUSLY RECORDED?	YES	<u>NO</u>
5.4	LABORATORY SPACE FREE FROM STAGNANT AIR POCKETS AND "HOT" OR "COLD" SPOTS?	<u>YES</u>	NO

Humidity

5.5	RELATIVE HUMIDITY WITHIN THE LIMITS OF 35% TO 65%	<u>YES</u>	NO

Vibration

5.6	IS THE LEVEL OF VIBRATION AND SHOCK SUCH THAT IT IS NOT LIKELY TO BE DETRIMENTAL TO THE OPERATION OF SENSITIVE INSTRUMENTS?	<u>YES</u>	NO

Acoustic Noise Level

5.7	IS THE ACOUSTIC NOISE LEVEL IN THE LABORATORY HIGHER THAN THAT OF A QUIET OFFICE?	YES	<u>NO</u>

Dust

5.8 IS A HIGH DEGREE OF LOCAL CLEANLINESS MAINTAINED BY MEANS OF REGULARLY SERVICED AIR FILTERS, GOOD ACCESS CONTROL, AND GOOD HOUSEKEEPING? YES NO

Electrical Measurement Requirements

5.9 ARE MEANS OF MEASURING WAVEFORM DISTORTION AVAILABLE? YES NO

5.10 WHERE PURITY OF WAVEFORM IS IMPORTANT, IS POWER SUPPLY DERIVED FROM AN OSCILLATOR AND AMPLIFIER SUITABLY SCREENED TO ELIMINATE MAINS INTERFERENCE? YES NO

5.11 ARE VOLTAGE STABILIZERS AVAILABLE WHERE NECESSARY? YES NO

5.12 IS AN EFFECTIVE MAINS EARTHING SYSTEM AVAILABLE? YES NO

5.13 ARE PRECAUTIONS TAKEN TO GUARD AGAINST THE PRESENCE OF UNWANTED MAGNETIC FIELDS FROM TRANSFORMERS, WIRING, ETC.? YES NO

Lighting

5.14 IS THE MINIMUM ILLUMINATION AT LEAST 100 LUMENS/SQ.FT. IN THE WORKING PLANE (EXCEPT WHERE A LOWER LEVEL OF LIGHTING IS REQUIRED FOR READING ILLUMINATED SCALES)? YES NO (50 lumens/sq.ft.)

6. CALIBRATION FACILITIES

In this section, information is requested on measurement areas in which calibrations can be performed. Please, therefore, as a minimum indicate with a tick, for each of the classes of measurement listed below, whether calibrations can be carried out. It would be very valuable, however, if, for each class, more complete information could be given under the following headings:

(a) RANGE OVER WHICH MEASUREMENT CAN BE MADE:

(b) FREQUENCY (WHERE APPROPRIATE FOR ELECTRICAL MEASUREMENT):

(c) BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY.

MINIMUM FORM OF REPLY (FULL REPLY ATTACHED):-

6.1 ELECTRICAL STANDARDS

✓6.1.1 D.C. Resistance
✓6.1.2 D.C. Voltage
✓6.1.3 D.C. Current
✓6.1.4 A.C. Current
✓6.1.5 A.C. Voltage
✓6.1.6 A.C. Power
✓6.1.7 Capacity
✓6.1.8 Inductance
✓6.1.9 Voltage Transformers

√6.1.10 Current Transformers
√6.1.11 Frequency

6.2 ENGINEERING METROLOGY

Length and Angle Standards

√6.2.1 Slip Gauges and Accessories
√6.2.2 Length Bars and Accessories
√6.2.3 Cylindrical Standards; internal and external
√6.2.4 Spherical Standards
√6.2.5 Thread Measuring Cylinders
√6.2.6 Linear Scales
×6.2.7 Surveying tapes
×6.2.8 Screw Pitch Measuring Standards
√6.2.9 Angle Gauges
√6.2.10 Polygons
√6.2.11 Circular Scales
√6.2.12 Engineers Squares
√6.2.13 Engineers Spirit Levels
√6.2.14 Vernier Calipers
√6.2.15 Vernier Height Gauges
√6.2.16 Dial Gauges
√6.2.17 Sieves
√6.2.18 Survey Levelling Staffs

Form

√6.2.19 Surface Texture
√6.2.20 Roundness
√6.2.21 Straightness

Engineers Limit Gauges

√6.2.22 Plain Plug Gauges
√6.2.23 Plain Ring Gauges
√6.2.24 Plain Gap Gauges
√6.2.25 Parallel Screw Plug Gauges
√6.2.26 Parallel Screw Ring Gauges
√6.2.27 Taper Screw Plug Gauges
√6.2.28 Taper Screw Ring Gauges
√6.2.29 Limit Gauges
√6.2.30 Profile Gauges

Miscellaneous

×6.2.31 Hardness Blocks
√6.2.32 Testing or Alignment of Machine Tools
×6.2.33 Stopwatches
√6.2.34 Anemometers
√6.2.35 Flow Meters
×6.2.36 Gear Measurement

6.3 MASS AND VOLUME

√6.3.1 Mass
√6.3.2 Knife-edge Balances
√6.3.3 Volumetric Glassware
√6.3.4 Density of Solids
√6.3.5 Density of Liquids
√6.3.6 Hydrometers

6.4 PRESSURE

√6.4.1 Mercury Barometers

√6.4.2 Aneroid Barometers
√6.4.3 Altimeters
√6.4.4 Barographs
√6.4.5 Manometers
√6.4.6 Pressure Gauges
√6.4.7 Vacuum Gauges

6.5 FORCE

√6.5.1 Materials Testing Machines
×6.5.2 Hardness Testers
×6.5.3 Impact Testers
√6.5.4 Elastic Force Measuring Devices, for normal use
×6.5.5 Elastic Force Measuring Devices, for calibration use

6.6 HEAT

√6.6.1 Laboratory Thermometers
√6.6.2 Thermocouples and Thermocouple Material
√6.6.3 Resistance Thermometers
√6.6.4 Optical Pyrometers
√6.6.5 Ribbon Filament Lamps
√6.6.6 Thermal Conductivity

6.7 PHOTOMETRY

√6.7.1 Luminous Intensity
√6.7.2 Luminous Flux
√6.7.3 Colour Temperature
√6.7.4 Total Radiation

7. SUMMARY STATEMENT

THE ABOVE QUESTIONS HAVE BEEN DESIGNED TO FIND OUT WHAT ARE THE AREAS OF STRENGTH, AND IN WHAT AREAS FURTHER WORK NEEDS TO BE DONE (BASIC NEEDS FOR STRENGTHENING AND EXPANSION).

IF YOU WISH YOU MIGHT LIKE TO MAKE A SHORT SUMMARY STATEMENT ON THE CONDITION OF AVAILABLE FACILITIES AND GIVE SUGGESTIONS FOR IMPROVEMENT.

In general our facilities are adequate, at present, for the job we have to do (except in the areas specified in 1.3); but as New Zealand develops industrially, we will have to increase the range and accuracy of all of our standards. The change to the metric system will require a special grant to meet the cost of providing for metric measuring equipment--particularly in the Engineering Metrology field. Our chief difficulty at the present time is shortage of 'air conditioned' space. The space we have is well controlled, but is very crowded.

Questionnaire on the Facilities for Basic Physical Standards of Weights and Measurement (Metrology) in South East Asia

Country: New Zealand

Date: 14 May 70

Completed by: Dr. M.C. Probine

(ALTERNATIVE ANSWER TO SECTION 6)

6. CALIBRATION FACILITIES

In this Section, information is requested on measurement areas in which calibrations can be performed. Please, therefore, as a minimum indicate with a tick, for each of the classes of measurement listed below, whether calibrations can be carried out. It would be very valuable, however, if, for each class, more complete information could be given under the following headings:

(a) RANGE OVER WHICH MEASUREMENT CAN BE MADE;

(b) FREQUENCY (WHERE APPROPRIATE FOR ELECTRICAL MEASUREMENT);

(c) BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY.

6.1 ELECTRICAL STANDARDS

QUANTITY	FREQUENCY	ACCURACY	REMARKS
6.1.1 D.C. Resistance			
100μΩ - 10mΩ		0.01%	
10mΩ - 1000Ω		0.003%	
1000Ω - 5MΩ		0.01%	
5MΩ - 100MΩ		0.05%	
100MΩ - 1TΩ		1%	Only with 10 volts potential difference
1, 10, 100,		0.0005%	
1000, 10,000Ω		0.001%	Precision type only
6.1.2 D.C. Voltage			
10pV - 100μV		10pV	Lower precision if output resistance high
100μV - 1mV		1μV	
1mV - 180mV		0.3μV	
180mV - 1.8V		3μV	
1.8V - 1.2kV		0.05%	
6.1.3 D.C. Current			
10pA - 10nA		2%	
10nA - 500nA		0.05% + 2pA	
500nA - 1mA		0.01%	
1mA - 100A		0.003%	
100A - 2kA		0.01%	
6.1.4 A.C. Current			
10mA - 5A	20 - 150Hz	0.01% - 0.05%	
5A - 6kA	50Hz	0.05% - 0.1%	Current supply only 3kA
10mA - 5A	150Hz - 1kHz	0.1% - 0.2%	

QUANTITY	FREQUENCY	ACCURACY	REMARKS
6.1.5 A.C. Voltage			
2.5V - 1kV	20 - 150Hz	0.01% - 0.05%	
1 kV - 6.6kV	50Hz	0.05% - 0.1%	
6.6kV - 33kV	50Hz	0.1% - 0.2%	
95 V - 105V	10 - 10kHz	0.01%	
1 V - 95V	10 - 10kHz	0.02%	A known variable voltage of this precision can be presented to a device of high input impedance. The precision decreases as the input impedance decreases. Higher voltages in this range can be measured but the precision will depend upon the voltage to be measured. The upper limit of voltage will depend upon the frequency.
6.1.6 A.C. Power			
25W - 5kW	20 - 150Hz	0.02% - 0.1%	V < 1 kV I < 1A
5kW - 528kW	50Hz	0.05% - 0.2%	V < 6.6kV I <80A
500kW - 198MW	50Hz	0.3%	V <33 kV I < 6kA Appropriate supply for high powers not available
6.1.7 Capacity			
10pF - 1μF	1kHz	0.01% or ½pF	Whichever is greater
1μF - 10μF	1kHz	0.1%	
10pF - 10μF	400Hz - 2kHz	0.1% or 5pF	Conservative
6.1.8 Inductance			
1μH - 100μH	1kHz	0.5%	
100μH - 1 H	1kHz	0.02% - 0.1%	
6.1.9 Voltage Transformers			
Standard Ratios	50Hz	0.1% and 2 minutes	
6.1.10 Current Transformers			
Standard Ratios	50Hz	0.02% and 1 minute	

QUANTITY	FREQUENCY	ACCURACY	REMARKS
6.1.11 Frequency			
	100kHz - 5MHz	$2x10^{-10}$-$5x10^{-10}$	Working Standards
	Up to 30MHz	$1x10^{-7}$	Laboratory Instruments
	30MHz -100MHz	$1x10^{-7}$ -$2x10^{-6}$	
	100MHz - 4GHz	$2x10^{-5}$ -$2x10^{-4}$	
	4GHz - 12GHz	$2x10^{-4}$ -$2x10^{-3}$	

6.2 ENGINEERING METROLOGY

QUANTITY/OR DEVICE	RANGE	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY
Length and Angle Standards		
6.2.1 Slip gauges and accessories	Up to Inspection grade	± 0.000003 inch
6.2.2 Length bars and accessories	Up to 36 inch	Inspection grade BS 1790
6.2.3 Cylindrical standards, internal & external	Up to 12 inch	0.1 to 2"± 0.00002 inch
6.2.4 Spherical standards	Up to 1 inch	± 0.00002 inch
6.2.5 Thread measuring cylinders		± 0.00002 inch
6.2.6 Linear scales	Up to 10 feet	± 0.003 inch
6.2.7 Surveying tapes	No	
6.2.8 Screw pitch measuring standards	No	
6.2.9 Angle gauges		± 5 seconds of arc
6.2.10 Polygons		± 2 seconds of arc
6.2.11 Circular scales		± 5 seconds of arc
6.2.12 Engineers squares	Up to 12 inch blade	± 0.0002 inch
6.2.13 Engineers spirit levels		± 2 seconds of arc
6.2.14 Vernier calipers	Up to 12 inch	± 0.001 inch
6.2.15 Vernier height gauges	Up to 12 inch	± 0.001 inch
6.2.16 Dial gauges		1 revolution ± 0.00015 inch
6.2.17 Sieves		BS Requirements
6.2.18 Survey levelling staffs	Up to 10 feet	± 0.003 inch

QUANTITY/OR DEVICE	RANGE	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY
Form		
6.2.19 Surface Texture	Talysurf	0.000001 inch
6.2.20 Roundness	Talyrond - Up to 14"	0.000002 inch
6.2.21 Straightness	Talylin - Up to 4"	0.00001 inch
Engineers Limit Gauges		
6.2.22 Plain plug gauges	Up to 12 inch	± 0.0001 inch
6.2.23 Plain ring gauges	Up to 12 inch	± 0.0001 inch
6.2.24 Plain gap gauges	Up to 16 inch	Small sizes ± 0.0001 inch
6.2.25 Parallel screw plug gauges	Up to 8 inch	± 0.0001 inch
6.2.26 Parallel screw ring gauges	Up to 8 inch	± 0.0001 inch
6.2.27 Taper screw plug gauges	Up to 8 inch	± 0.0002 inch
6.2.28 Taper screw ring gauges	Up to 8 inch	± 0.0002 inch
6.2.29 Limit gauges 6.2.30 Profile gauges	Depends on type of gauge	
Miscellaneous		
6.2.31 Hardness blocks (Force)	No	
6.2.32 Testing or alignment of Machine Tools (Engineering Metrology)	Yes	Depends on type of machine
6.2.33 Stopwatches (Time)	No	
6.2.34 Anemometers (Air Flow)	50 to 3500 F.P.M.	10 F.P.M. or 5% whichever greater
6.2.35 Flow Meters (Fluid Flow)	No	
6.2.36 Gear measurement (Engineering Metrology)	No special gear measuring equipment	
6.3 MASS AND VOLUME		
6.3.1 Mass	100kg	1 part in 1,000,000
6.3.2 Knife-edge balances	Not for Clients	
6.3.3 Volumetric glassware		BS Requirements
6.3.4 Density of solids		1 part in 100,000
6.3.5 Density of liquids		1 part in 100,000
6.3.6 Hydrometers		0.0001 g/cm^3

QUANTITY/OR DEVICE	RANGE	BEST MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY
6.4 PRESSURE		
6.4.1 Mercury barometers	40 to 900 mm Hg	± 0.01 mm
6.4.2 Aneroid barometers	40 to 900 mm Hg	± 0.01 mm
6.4.3 Altimeters	20,000 m	0.15 m
6.4.4 Barographs	40 to 900 mm Hg	± 0.01 mm
6.4.5 Manometers	40 to 900 mm Hg	± 0.01 mm
6.4.6 Pressure gauges	0 to 27,000 P.S.I.	0.25%
6.4.7 Vacuum gauges	Up to 30 inch Hg	0.25%
6.5 FORCE		
6.5.1 Materials testing machines	Up to 100 ton tension & 200 ton compression	0.5%
6.5.2 Hardness testers	No	
6.5.3 Impact testers	No	
6.5.4 Elastic force measuring devices	Up to 100 ton	Up to 50 ton 0.1%, above 0.3%

Note:-

Accuracies and ranges greater than those listed above can be achieved for special jobs. The ranges and accuracies given above are those that can be achieved routinely, without resorting to special procedures or 'set-ups'.

6.1 - SUPPLEMENTARY LIST - ELECTRICAL MEASUREMENTS AT RADIO FREQUENCIES

QUANTITY	ACCURACY	FREQUENCY RANGE	POWER/VOLTAGE SOURCE AVAILABLE AT P.E.L.	REMARKS	"TRACEABILITY"
Power					
1 - 10 mW	± 2%	0-1000 MHz	Up to 1200 MHz	R & S "Dezifix B" 50Ω connector only	Checkable at DC
" "	± 5%	1000-2000 MHz			
" "	±10%	2000-4000 MHz			
" "	± 2%	0- 800 MHz	Up to 5 mW	Type N 50Ω connector	
10 - 400 mW	± 5%	0- 800 MHz			
400mW - 100 W	±10%	0- 600 MHz			
Attenuation					
0 - 10 db	±0.1 db	0- 800 MHz			Checkable at DC
10 - 30 db	±0.3 db	0- 800 MHz			
30 - 100 db	±0.5 db	0.5- 30 MHz			
Voltage					
1 mV - 300 V	± 2%	1 kHz - 1MHz	Up to 5 volts		Checkable at 1 by dynameter. Other frequencies by power meter to 6% at 200 to 500 mV.
	± 5%	1 - 4 MHz			
20 - 200 mV	±10%	4- 200MHz	Up to 500 mV		
200 - 700 mV	± 6%				
700mV - 10 V	±10%				
Impedance/ Admittance					
R 100Ω- 1MΩ	± 1%	15 kHz - 5 MHz		balanced or unbalanced	Checkable at some spot values by reference to
C 1pF -20,000 pF	± 1%				
L 1μH - 0.01 H	± 3%				
C ± 80pF	±0.5 pF or ± 2%	5 - 100 MHz		"	audio or DC calibrations of
g 0 - 100 mS	±0.025 mS or ± 2%				
C ± 75 pF	±0.5 pF or ± 2%	5 - 250 MHz		unbalanced only	standards of known frequency coefficient.
g 0 - 100mS	± 1 mS or ± 2%				

NBS SPECIAL PUBLICATION 359 - Metrology and Standardization in Less-Developed Countries: The Role of a National Capability for Industrializing Economies. Proceedings of a Seminar, 1971.

APPENDIX 5

STANDARDS LABORATORIES ASSISTANCE TO DEVELOPING INDUSTRY

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The following brief extracts*, taken from a submission to the Parliamentary Standing Committee on Public Works, Australia, may be of interest to the NBS/AID Seminar as showing some of the services to industry of a national standards laboratory. The last extract deals with the research program. Table 1 lists the NSL fields of work, and Table 2 allots the floor space in the present and the proposed new buildings.

1. Advice and Assistance to Industry

The National Standards Laboratory of CSIRO provides advice and assistance to industry in a wide variety of technical problems but more particularly in relation to measurement. Some examples can be quoted to indicate the kinds of problems dealt with.

(i) A firm manufacturing sheet material by a continuous process was assisted with control of measurement at the stage of manufacture where the material is soft. The Laboratory developed a pneumatic gauge specifically for this application so that measurements could be made without direct physical contact with the soft material.

(ii) A manufacturer of spark plugs who was losing a high proportion of plugs through cracking of the ceramic insulators during firing was given assistance to determine the correct thermal conditions.

(iii) High quality weights for laboratory use are now commercially produced in Australia by a firm which was given substantial assistance in the project by officers of NSL.

(iv) The loan of semi-automatic equipment for measuring relative humidity, developed in NSL, enabled a company heat-treating transformer steel in large stacks to determine the cause of problems which had led to the loss of several charges each valued at about $10,000.

(v) Several firms have been assisted in the development of rooms screened so as to prevent electrical interference from outside sources.

(vi) Electric supply authorities have been able to make more efficient use of some transmission lines through application of findings from research at NSL on the heating effects of the current carried.

(vii) During World War 2, the resources of the Laboratory, then much less developed than they are at present, were fully devoted to

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* Communicated by Dr. H. C. Webster, Scientific Counsellor, Embassy of Australia, Washington, D. C. 20036.

dealing with problems of wartime production. The laboratory would again be a vital factor in permitting manufacturing industry to meet new demands quickly should an emergency arise.

Several years ago a unit was installed at a Sydney manufacturing plant for the testing of helicopter gear boxes. The unit was designed to provide for long-duration tests on gear boxes under loads similar to those involved in normal operation. For successful operation it was essential that the component parts of the test rig, which is 28 feet high and 12 feet wide, should be placed with an accuracy of a few thousandths of an inch. Officers of NSL devised a special method of ensuring that this was accomplished.

Assistance has been given recently to those concerned with the measurement of volumes in the exploitation of petroleum from Australian fields. Continuous volume-measuring equipment of very high capacity is being used and the Laboratory in addition to providing the basic calibrations necessary has been able to advise on the most satisfactory methods of measurement for routine use.

The group concerned with measurements of light and other forms of radiant energy has been able to assist a large number of research workers concerned with investigations on primary-industry problems. These have included investigations relating to crop and pasture growth, the cold storage of meat and the development of fisheries. The group has also been able to assist the Commonwealth Bureau of Meteorology and the CSIRO Division of Meteorological Physics by calibrating equipment used in the measurement and study of solar radiation. The group has also been able to give advice in connection with many secondary-industry problems and has advised traffic authorities and manufacturers in relation to road marking lines, road signs and reflecting materials.

The Thermometry Group is often called on for help with industrial temperature measurement and related problems; a typical case was one in which a manufacturer was experiencing difficulty in the continuous waterproofing of woven nylon material. Initially the problem was to achieve a uniform product. In addition, it was found necessary to install a new machine but until uniformity could be achieved on the first machine specifications could not be determined for the new one. NSL officers were able to develop methods for measuring the temperature of the moving sheet with sufficient accuracy. This made it possible both to correct the performance of the first machine and to determine the requirements for the new machine.

These are examples taken from a very large number. Assistance of this kind to industry continues to be a most important part of the work of the Laboratory. Besides its direct value to industry it is one means of keeping officers of the laboratory informed about current trends in industry and thus assists in the planning of research activities.

2. Physical Research Program

Section 9 of the Science and Industry Research Act 1949-68 makes CSIRO responsible, among other things, for "the initiation and carrying out of scientific researches and investigations in connection with...primary or secondary industries in the Commonwealth...." The research responsibilities of NSL are interpreted by the Executive of CSIRO and the Chiefs of the two Divisions as covering:

(i) areas which may lead directly to improved accuracy in establishing standards of physical measurement;

(ii) natural phenomena and the properties of materials or the laws of nature which it considers likely to be of benefit to primary or secondary industry in the Commonwealth; and

(iii) areas where the specialized knowledge and techniques of the Laboratory may be exploited either for the benefit of industry or the advancement of knowledge.

Such research keeps staff alert to possible new means of establishing standards of measurement using new techniques or newly discovered scientific laws. The main fields of research are closely allied to standards of measurement.

Solid State Physics

This involves measuring and understanding the physical properties of solid materials under widely differing conditions of temperature or pressure. Three separate groups are engaged in such activities.

(i) A group allied to temperature standards is concerned particularly with properties which are temperature-sensitive, both at extremely low and high temperatures. These include the conductivities of heat and electricity, thermal expansion, compressibility, and others, which are all of scientific interest and increasing technical importance in industries based on metallurgy, aerospace, liquefaction of natural gases, electronics, and nuclear power.

(ii) Dielectric and magnetic properties of solids are studied by the group which is responsible for dielectric and magnetic standards, such properties being of prime importance to industry and science.

(iii) A third group is concerned with paramagnetic resonance properties of solids, which enable one to understand better the roles of impurities and small concentrations of other elements, on which the properties of many solids are vitally dependent.

Fluid State Physics

The Fluid Physics Group, concerned with standards of viscosity and humidity, has a major interest in the basic properties of liquids at high pressures. This includes also a study of gases at pressures so high that their densities may approximate those of their liquid forms. Research in this field has resulted incidentally in new methods of measuring high pressures.

Solar Physics

Solar astronomy has provided an excellent opportunity for exploiting the Laboratory's expertise in optical instrumentation. In turn, this has led, among other things, to the development of a new kind of optical component now known widely as the "active optical element."

The Laboratory maintains a solar observatory at Culgoora, near Narrabri, northwestern N.S.W., for basic research on the sun's outer layers. Astronomers have their base at NSL but go to Culgoora, where there is a resident maintenance staff, on rosters. The space requirements for solar physics within the present and proposed NSL buildings are therefore relatively light.

Production Engineering

A group is concerned with the machinability of metals and the geometric analysis of engineering designs, both of which can be very important factors in production efficiency.

3. Environmental Requirements

A wide variety of special facilities have been developed by NSL to establish the basic standards of measurement and provide the extensive calibration service necessary to relate measurement throughout the community to these standards. Much of the proposed laboratory space is to be used to house these facilities adequately as permanent installations, and the closely controlled environment that has been specified is necessary to achieve the high technical performance required. Recent dramatic improvements in the sensitivity and accuracy of measuring techniques have been such that at NSL level the main limitations in many instances are now environmental. Temperature and humidity variations and mechanical vibration are serious limitations in many fields, and there is no feasible way of controlling these to the necessary extent in the present building.

In planning the new laboratories, our approach to this problem has been to seek the best possible conditions that are available commercially at reasonable cost. This has resulted in an air-conditioning specification with tolerances of ± 1°F in temperature and ± 5% in relative humidity.

From our discussions with the Department of Works it is apparent that the only reasonably economic way of achieving low levels of vibration is to have floors resting wholly on the ground. Approximately one third of our space requires low vibration levels and the tendency is for this fraction to increase. This is the main factor which has limited the proposed development to two stories.

With all of the laboratory space controlled to these conditions and with half of the floor space with low vibration, it will be possible to install much of our equipment without additional treatment. Some apparatus, however, will still have to be immersed in closely controlled oil baths (0.001°C) and some will have to be mounted on air bags or other special anti-vibration mountings.

In the present accommodation some of these problems of environment have had to be solved in a makeshift and inefficient manner and in others research work has been put aside until an improved environment is available.

4. Accommodation Requirements

Individually, many of the facilities of NSL do not require particularly large floor areas for their accommodation. Accordingly most of the laboratory space has been provided in General Purpose Laboratories with the aim of having maximum flexibility to meet future needs and changes. Approximately 15% of the proposed General Purpose Laboratory space is available either for expansion of the work of existing groups or for new groups which do not have special architectural requirements and whose work would be compatible. New activities such as acoustics would require a special building. As far as the calibration service is concerned, once facilities are permanently set up there will be spare capacity to meet an increased calibration demand in most fields of measurement.

Special buildings and architectural arrangements have had to be provided for the following sections shown in Table 2: High Voltage Laboratory, Standard of Force, Geodetic Base, and Photometry/Radiometry/Optics.

TABLE 1

Name of Group	Fields of Work	Typical Research Projects and Industrial Problems
Mass	Mass, density, pressure, precision lapping	Absolute determination of gravity at Sydney Microtome knife sharpener Hydrometer for opaque liquids
Length	All aspects of engineering metrology including length standards, angle standards, gauges, gears, screws, etc.	Geometrical shape of Parkes radio telescope Alignment e.g. steel rolling mills Helicopter test rig Acetylator A.P.I. tapered screw threads Surface finish Geodetic base and long length measurements
Interferometry	The application of optical interference techniques to measurement including the fundamental standard of length	Line standard interferometer Fabry-Perot scanning interferometer Stabilized lasers for length standards Stability of low expansion materials
Applied Mechanics	Force, hardness and pressure	Sources of error in hardness and pressure measurement Force transducers
Vibration	Vibration measurement and control	Absolute calibration of vibration measuring instruments using optical interference Vibration isolation of sensitive instruments and machine tools Measurement of vibration caused by machinery, vehicles, quarry blastings, etc. Investigation of vibrations of buildings, bridges, ships, Parkes radio telescope, etc. Dynamic balancing of machinery

Name of Group	Fields of Work	Typical Research Projects and Industrial Problems
Electrical Standards, Time and Frequency	Fundamental electrical standards and standards of time and frequency	Absolute determinations of the ohm and the volt Atomic hydrogen frequency standard Temperature bridge
Power Frequency	Standards for the power supply industry including high voltage standards	Corona discharge at high voltages Thermal behavior of overhead transmission lines Corona-free transformers Static electricity in printing, paper handling and hospitals Transient performance of protection transformers
Radio Frequency and Microwave	Standards at high frequencies mainly for the communications and defense industries	More precise methods of impedance, power attenuation and microwave noise measurement Reflectometers
Dielectrics and Magnetism	The electrical and magnetic properties of materials	Instrumentation over a wide frequency range Magnetic survey of Australian steels The relation between defects and impurities and the dielectric properties of solids
Thermometry	Establishment and dissemination of the International Practical Temperature Scale	Stability of base-metal thermocouples Firing of ceramic in spark plugs Adhesion of brake linings to brake shoes Production of gramophone records Casting of iron in foundry sand moulds Cooling of animal semen for artificial fertilization Hyperthermia Cauterizing of corneal ulcers
Optical Radiometry	Standards of measurement of radiant intensity, luminous intensity, luminous flux, color temperature, color	Radiant energy scales and spectral energy distribution Illumination levels in crops and pastures Optical properties of diffusers with special reference to color control

Name of Group	Fields of Work	Typical Research Projects and Industrial Problems
		in the paper, glass, aluminium, paint, plastics, textiles, leather, food, articicial tooth and ceramics industries Color rendering requirements in hospital lighting Methods of testing military flares
Fluid Physics	Viscosity and humidity	Accurate and novel methods of humidity measurement Maintenance of viscosity scale and development of improved viscometers New absolute method of measuring high pressures Properties of fluids at very high pressures
Optics	Performance of optical instruments and properties of optical materials	Lens testing interferometers Multiple beam interferometers Precision polarimeter for sugar industry Production of ultra-flat optical surfaces
Solid State Physics	Properties of solids particularly at low temperatures	Thermal and electrical conductivities Thermal expansion Specific heat Elastic properties
Paramagnetic Resonance	Paramagnetic resonance spectroscopy	Studies of aggregation in solids
Solar Physics	The solar photosphere and chromosphere	Solar flares Velocities and magnetic fields and their significance in solar phenomena
Production Engineering	Production engineering	Machinability of metals and geometric analysis of engineering designs

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TABLE 2

Existing and Proposed Net Usable Areas, NSL
(Excludes passages, stair and lift wells, toilets, etc.)

	Existing Sq. Ft.	Proposed Sq. Ft.
Laboratories and Offices		
(1) General Purpose (approximately 15% is for future expansion)	65,600	124,000
(2) High Voltage	2,900	19,000
(3) Geodetic Base	1,300	3,000
(4) Standard of Force	-	3,000
(5) Photometry, Radiometry and Optics: Shared Tunnel	-	2,500
(Below ground. Some general purpose areas are used by this section)		2,200
(6) Flat roof areas	400	1,200
Laboratory Services		
(1) Workshops	16,800	25,400
(2) Drawing Offices	2,200	5,000
(3) Stores	8,000	10,000
(4) Computing Facilities	-	1,000
(5) Cryogenics	700	2,200
(6) Photographic Facilities	1,100	1,800
(7) Glass Blowing	700	1,300
(8) Optical Workshop	1,200	2,200
Administration	5,100	8,000
Conference and Colloquium Rooms	400	3,200
Lecture Theatre	-	3,300
Library	4,900	9,300
Cafeteria and Amenities	4,500	6,400
	115,800	234,000

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The Role of a National Capability for Industrializing Economies.
Proceedings of a Seminar, 1971.

APPENDIX 6

PROMOTION OF EDUCATION, SCIENCE AND TECHNOLOGY BY THE INTER-AMERICAN DEVELOPMENT BANK

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1. Background

The Inter-American Development Bank is an intergovernmental agency set up to help speed the process of economic development, both individual and collective, in its member countries. The Bank does this by financing projects throughout the region in different fields of social and economic development, using its own capital, funds which it raises in the money markets, and resources which it administers on behalf of others. IDB began operations on October 1, 1960, and authorized its first loan early in February 1961.

The Bank has from the outset devoted priority attention to education as a sector of vital importance for the development of Latin America; its first loans to this sector were approved in 1962. Ever since then its operating policy on loans to education has been under constant and systematic review so as to adapt it to the changing needs of the Bank's member countries.

2. Fields of Action

The principal aim of the Bank's activities in the field of education is to support the efforts of its members in the following areas:

(i) Higher education

(ii) Technical and vocational education

(iii) Scientific and technological development.

In the field of higher education preference is given to programs that are closely connected with economic and social development plans. Encouragement is given to programs involving the technological and agricultural sciences, and in particular to the teaching of the basic sciences as they form the academic backbone of all educational programs. Also eligible are programs to further the teaching of the applied social sciences (economics, sociology, etc.), pedagogics, public administration, business management and public health, including medical sciences, etc.

In the case of technical and vocational education the Bank helps to finance programs designed to train medium-level technicians for work in agriculture, industry and business and to train and upgrade skilled operatives and personnel for a variety of jobs and services.

In the scientific and technological sector the Bank supports research programs at universities and other specialized institutes in order to increase basic knowledge in the natural and social sciences and of their technological application. It helps to develop standards institutes; map, geological, topographical, meteorological, hydrological and other services; and informational and scientific infrastructure services. It also sponsors the establishment or strengthening of councils, foundations, societies and other organizations for planning and coordinating scientific and technological policy.

Loan contracts sometimes include provisions that permit borrowers to erect research laboratories, if the size of the project so warrants, or to retain the services of consultants or of technological research institutes to improve existing or introduce new systems and methods.

3. Amount and Purpose of Loans

Between 1962 and January 1971, the IDB made 59 loans totaling the equivalent of US $202,410,000 to educational establishments in almost every country of the region. These loans helped finance projects with a total cost of US $417,076,800 which represents a very substantial effort in mobilizing local resources for investment in education.

Loans to education are generally intended to create the right kind of conditions for expanding and improving educational and scientific and technological research institutes. Most of IDB's contribution has gone into strengthening institutional development programs and improving the teaching of and research into basic and applied sciences (agriculture and engineering). Funds have also been made available for intermediate-level technical education programs, the teaching of medicine and social sciences, and teacher education and training.

The loan funds have for the most part been invested in the construction of buildings, the purchase of equipment for teaching or research laboratories, the purchase of bibliographical material, the training and upgrading of teaching and research staff, and technical assistance programs.

4. Resources Used

In carrying out its educational programs IDB at first used the resources of the Social Progress Trust Fund established under an agreement with the United States Government as part of the Alliance for Progress program.

By 1966 these trust funds had been fully committed and the Bank began to finance educational loans by drawing on its Expanded Fund for Special Operations. The change in source of financing gave the Bank an opportunity to modify its policy in this sector by including medical sciences among the eligible fields at the university level and technical and vocational education at the non-university level, as well as support to independent research institutes not directly connected with education. Although the Bank has been drawing on the Fund for Special Operations to finance its most recent loan operations, it has also made use of resources from the Canadian Fund and may possibly mobilize Bank-administered funds from other sources. Its lending terms can vary depending on the source of the loan funds.

5. Technical Assistance

IDB provides national and regional institutions with technical assistance in preparing and executing development plans and projects, as well as in training the personnel needed to carry them out. Such assistance can take the form of a grant or a reimbursable advance, depending on the kind of operation involved.

Some loans for educational purposes have included reimbursable amounts for technical assistance. Moreover, technical assistance operations of both kinds have been authorized to finance surveys connected with institutional development, identification and preparation of educational projects, and assessment of financing needs for the expansion of scientific and technological research.

6. Training and Other Activities

The Bank sponsors advanced training for professional personnel in the Latin American countries through courses and seminars which it organizes itself or jointly with specialized agencies in the region or in each country. In addition, many fellowships have been awarded for these courses, and funds have been made available for organizing studies, lecture series, meetings, publication of papers, etc. Some of these activities took place at universities and other institutions offering regular programs of higher education.

One of the surveys conducted was on the status of agricultural education, research and extension in a number of Latin American countries. These and other similar studies have been completed or are being carried out in collaboration with other international agencies or agencies belonging to the inter-American system.

Concerned at the lack of specialized reference texts and works in Spanish in the countries of the hemisphere, IDB decided to sponsor the preparation and publication of a collection of 200 books on economics in collaboration with the International Bank for Reconstruction and Development and the Latin American Center for Monetary Studies (CEMIA). The collections were distributed as gifts among higher education, governmental, financial and other institutions engaged in this field of activity. This collection met with such a response that supplies are now virtually exhausted.

In the field of integration another Bank effort being carried out through the Institute for Latin American Integration (INTAL) in cooperation with CEMIA, is the compilation of 200 collections of 50 books and documents on the subject of Latin American integration.

7. Main Features of the Projects

In the fields of education, science and technology IDB's loans tend to be at long term and low interest. They are made to both public and private institutions provided that the applications have been approved by the government concerned and are backed up by a project embodying clearly defined objectives to be achieved in a given period of time. A description is given below of some of the features which are considered typical of projects in the fields of education, science and technology.

8. Academic and Institutional Development

In the three fields under consideration the Bank prefers to assist projects aimed at the overall development of institutions, in terms not only of improving the academic standards of their teaching and research activities but also of expanding them and adapting them to meet the current economic, social and cultural development needs of the country and the region.

The projects should define specific measures, which can be implemented during the loan disbursement period, to reform the institutional structure with a view to achieving more efficient use of resources, updating the curriculum and introducing more effective teaching methods, adopting research programs in the case of universities, strengthening meaningful ties between the institutions and the communities they serve, and modernizing administrative and accounting systems and procedures.

The Bank lends its full support to initiatives on the part of institutions or groups of institutions to bring about the regional integration of Latin America. It also sponsors projects designed to further the overall and balanced growth of scientific, technological and humanistic knowledge, by supporting efforts to train the leading teams in the fields concerned.

Capital expenditures under the projects must be clearly connected with the plans for institutional, academic and administrative reform, mentioned above, and serve to facilitate their implementation.

9. Training of Teaching and Research Staff

The success of any institutional reform or development effort lies in the caliber of the personnel responsible for carrying it out. IDB considers it to be of fundamental importance that educational, scientific and technological projects should include provision for a program to train members of the teaching and research staffs by means of specialized courses of study in their own countries or abroad. These systematic training programs are rounded out by the introduction of full-time teaching careers in all disciplines where teaching and research are full-time occupations.

10. Student Assistance

The Bank appreciates how important it is to help students from the lower income brackets to continue their education, to allow them to devote themselves full-time to their studies and practical work, and to participate without outside restrictions in all the activities that are part and parcel of a worthwhile professional training. Accordingly, it supports projects that provide for fellowships, student loans, or other forms of economic assistance to students.

11. Planning

To encourage systematic planning in educational and scientific and technological research institutions the Bank provides technical and financial assistance when needed to formulate an investment project, but it also tries to ensure that the projects include programs aimed at institutionalizing planning activities.

12. Scientific and Technological Research

As a rule, projects intended to finance the programs of independent research institutes should possess the following features:

(i) The institute must be in a position to provide suitable employment to enough high-trade scientists to permit effective work to be done that will be of potential influence both nationally and regionally.

(ii) The research program should be designed preferentially to meet the needs of the top priority sectors as far as the development of the country or region is concerned, and a survey should have been conducted to gauge the potential demand for the institute's services.

(iii) Arrangements must be made to ensure that research and other technological data arising out of the institute's activities are distributed efficiently among prospective interested parties.

(iv) The institute should charge suitable rates to recoup the cost of its services.

(v) The institute should cultivate close relations with university research centers, other technological research organizations in its particular field and the principal foreign research centers engaged in areas related to its own.

13. Other Projects

Other independent agencies are eligible for assistance under this program provided that their proposed activities are aimed at:

(i) Standard institutes:

(a) establishing a system of weights and measures
(b) calibrating instruments and equipment
(c) setting measurement and quality standards for products
(d) promoting efficient quality control systems

(ii) Other scientific and technological services:

(a) agricultural research and related extension services
(b) cartography, geology and topographic surveys
(c) programs for the conservation and rational use of basic natural resources
(d) meteorological and hydrological services
(e) systems for compiling and disseminating reports

(iii) National scientific organizations:

(a) national research councils, academies of sciences, and similar organizations dedicated to pursuing or initiating a national policy aimed at coordinating and encouraging the country's scientific and technological development
(b) organizations that administer fellowship programs and train manpower for science and technology
(c) organizations for promoting scientific research, provided that there is a suitable balance between basic and applied or technological research, that the national and regional research efforts are properly coordinated, and that sufficient administrative and technical capacity exists for selecting and executing projects.

(iv) Multinational or regional institutions:

(a) support for national "centers of excellence" whose influence is felt throughout the region or whose geographical location makes them "natural laboratories"
(b) regional programs in which the efforts of the different national centers are pooled
(c) establishing multinational institutions provided that they meet an important need which cannot be met by existing or planned national organizations
(d) joint programs agreed upon by laboratories and universities in different countries.

14. Loan Requirements and Conditions

<u>General Requirements</u>

A project must comply with the following conditions in order to merit consideration by the IDB:

(i) It must be intended to promote the improvement of university education, of technical education at its various levels, or of scientific and technical research, with a view to perfecting the quality and efficiency of these activities.

(ii) It must specify the concrete measures which the institution has adopted, or proposes to adopt, to effect the integration of its teaching and research activities, raise the academic quality of its staff and ensure a dynamic relationship between its activities and the needs of the community.

(iii) It must meet clearly identified needs of the educational, scientific and technological sectors, in terms of the needs of the economic and social development planning of a country or region.

(iv) It must be part of a national development plan and must have been approved by the government, with a high priority within the program of external financing.

The following must be assured for a loan application to be processed:

(v) The applicant organism will have the resources necessary to executing the project, to contributing to financing an adequate part of the project, and to covering major operating costs deriving from execution of the project.

(vi) The requested financing will be used for special capital investments by expansion of physical facilities, equipping laboratories and shops, scientific instrumentation, library materials, advanced training of teaching and research staff and contracting for temporary technical assistance in the introduction of academic or administrative reforms.

(vii) The organism responsible for execution of the project must have the organization, ability and technical experience necessary to comply efficiently with the proposed program.

Principal Contractual Conditions

Loans granted by the IDB for educational, scientific and technological development are subject to financial conditions which are applied in a general manner, but which are subject to minor readjustments in each case, depending on the characteristics of the project, the potential of the borrower and the use of the various funds which the Bank administers. Following are some of the contractual conditions established for operations financed by the Fund for Special Operations:

(i) Its constituent agreement empowers the Bank to make loans to public and private sector organisms of its member countries.

(ii) Terms established by the IDB for the reimbursement of loans vary in accordance with the characteristics of each project. The minimum term is generally 15 years.

(iii) Interest is at the rate of 2.25 percent on disbursements made, payable in the same currency as disbursements.

(iv) A service charge of 0.75 percent a year is made on disbursements effected.

(v) A charge of 0.50 percent is made on the undisbursed portion of loans.

(vi) The Bank generally grants a sufficiently long grace period to ensure efficient functioning of the project. The duration of this period will be fixed by mutual agreement and will not be shorter than the period for execution of the project.

(vii) Disbursements may be made in any of the currencies constituting the capital of the IDB. Repayment may be made in the currency of the debtor country.

(viii) Loans to governments and certain government agencies have been made on the basis of the general responsibility of the borrower; in other loans the Bank has obtained specific guarantees of another type.

(ix) In all projects financed by the Bank the borrower must agree to make an investment from his own resources, the amount of which varies, among other reasons, on the basis of his economic possibilities, the size of the loan and the kind of project.

Application of Loan Funds

Resources of loans granted by the IDB for educational, scientific or technological development may be invested in financing any of the items enumerated above, with the exception of land purchase, contracting full-time teachers, maintenance costs and financial costs. Resources of an IDB loan may not be utilized to refinance debts or for normal operating costs of the borrower institution.

Goods and services financed from the Fund for Special Operations may be acquired in the borrower country or in the United States, and, with the express authorization of the Bank, in any other member country of the IDB.

15. Guide for Preparing Project Requests

The Bank, for the study of each project, requires an organized body of information which will permit it to evaluate the merits of the project; its technical, administrative and financial feasibility, and its effects on the economic and social development of the country. This information must be presented in accordance with an extended questionnaire which is obtainable (in Spanish or English) from the author.

APPENDIX 7

LIST OF PARTICIPANTS
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APPENDIX 8

BIODATA OF SEMINAR AUTHORS

Beck, Niels C.

Born 1912 in Denver, Colorado; educated in chemistry, geophysics, and law. Dean of Park College, Denver, Colorado, 1946-1953. Armour Research Foundation, 1953-1956. Director Industrial Center, then Industry Advisor AID/Korea, 1956-1967. Deputy Assistant Director for Industry, then Chief Industrial Advisory and Promotion Branch, AID/Vietnam, 1967- . Author, "The Threshold of Industrial Development."

Bernstein, Joel

Dr. Bernstein received his Ph.D. from the University of Chicago. He is an economist, foreign affairs specialist, and AID administrator. AID program since Marshall Plan, 1948. He served 16 years in field service in Europe, Africa, and East Asia. Mission Director Nigeria and Korea, then Director of Program Evaluation of AID, 1959-1967. From 1969 to the present he has been Assistant Administrator for Technical Assistance, AID.

Brady, Edward L.

Born Charleston, South Carolina, 1919. Undergraduate work at University of California at Los Angeles and Ph.D. in physical chemistry at Massachusetts Institute of Technology, 1948. Nuclear power plant experience with General Electric Company and Gulf General Atomic. U. S. Atomic Energy Commission representative, London, England, 1956-1958. Senior Advisor, U. S. Mission to the International Atomic Energy Agency, Vienna, Austria, 1959-1961. At NBS, Chief of Office of Standard Reference Data, 1963-1968; Associate Director for Information Programs since 1968.

Branscomb, Lewis M.

Dr. Branscomb, a physicist, was appointed as Director of the National Bureau of Standards by President Nixon in September 1969. He was born in North Carolina in 1926, educated at Duke University and Harvard University (Ph.D. 1949). Serving on the NBS staff since 1951, he was a Fellow at University College, London, 1957. He is a member of the National Academy of Sciences, and served on the Panel on International Technical Cooperation and Assistance, of the President's Science Advisory Committee. Most recently he was a member of the President's Task Force to plan for the proposed International Development Institute. He is the scientific representative of the U.S.A. in the International Conference of Weights and Measures (CGPM) and the Committee on Data for Science and Technology (CODATA) of the International Council of Scientific Unions (ICSU).

Cali, J. Paul

Mr. Cali is Chief, Office of Standard Reference Materials at the National Bureau of Standards. He received a B.A. in chemistry from Brown University in 1949; graduate studies in astronomy, radio chemistry and instrumental methods of analysis. He worked for the U.S. Atomic Energy Commission 1949-1950; U.S. Air Force Cambridge Research Laboratories, 1951-1966, and has been at NBS since 1966. He has contributed more than 20 papers and one book in the field of nuclear methods of analysis, especially for trace constituents.

Condon, Edward U.

Dr. Condon was the fourth Director of the National Bureau of Standards, serving from 1945-1951; he has the distinction of having recruited the present (sixth) director when the latter was a graduate student at Harvard. He left NBS to become director of research and development for Corning Glass Works. Later he was Chairman of the Department of Physics of Washington University, St. Louis.

He joined the faculty of the University of Colorado in 1963 as professor of physics and fellow of the Joint (Colorado University plus NBS) Institute for Laboratory Astrophysics there. He became Emeritus Professor and Fellow in July 1970. He is notorious for having headed the Scientific Study of Unidentified Flying Objects sponsored by the U.S. Air Force in 1967-1968.

Cushen, W. Edward

Born Hagerstown, Maryland, 1925; undergraduate work at Western Maryland College; Ph.D. in logic and metaphysics, University of Edinburgh, Scotland, 1951; D.Sc. Western Maryland, 1966. Computer programmer on Bell Relay Computer, ORDVAC, and UNIVAC I. Operations research project leader at Army's Operations Research Office, 1952-1961. Associate Professor of Operations Research, Case Institute of Technology, 1961-1963. Staff member at Institute for Defense Analyses, working on analysis of political games under conditions of disarmament proposals, 1963-1964.

Dr. Cushen came to NBS in 1964, where he is Chief of the Technical Analysis Division, whose purpose is to help agencies of civil government to use the systems approach in a productive way. In 1970, he was elected President of the Operations Research Society of America.

Day, Melvin S.

Educated as a chemist, Mr. Day worked on the Manhattan Project in 1943. He joined the technical information program of the U.S.A.E.C. in 1946, moving up to become its Director. In 1960, he transferred to the National Aeronautics and Space Administration as Director of the Scientific and Technical Information Division, and became Deputy Assistant Administrator for Technology Utilization in 1965.

Escobar V., Ismael

Dr. Escobar was born in Bolivia in 1918, and educated in Spain, with a doctorate in mathematics and physics from the University of Barcelona. He has studied aerology in France, and held a Guggenheim fellowship in physics at the Massachusetts Institute of Technology. He founded the Meteorological Service of Bolivia in 1942, and was Professor of Physics and Executive Director of the National Commission of Nuclear Energy in La Paz until he joined the Inter-American Development Bank in 1963. As research associate and visiting professor he has served several universities in the U.S.A., and has presented papers at numerous conferences in Latin America and Europe.

Felleke, Zawdu

Mr. Felleke was born in Dessye, Ethiopia in 1941. He received a B.Sc. from Haile Selassie I University in 1963 and a M.Sc. from Michigan State University in 1966. He is presently Acting General Manager of the Ethiopian Standards Institution.

Fontes, Alfredo

Mr. Fontes was born in Uruguay. He holds a chemical engineering degree from the University of Uruguay, and has done post-graduate work at American University. He has been with the Organization of American States since 1961, and is presently Chief, Unit for Technological Development, Department of Science and Technology.

Ghosh, A. N.

Born in 1911, Dr. Ghosh earned the M.Sc. degree in Calcutta University in Inorganic Chemistry, 1935. He then proceeded to Germany and received the Doctorate of Natural Sciences in 1939. On return to India Dr. Ghosh has been Lecturer at the University of Calcutta, Deputy Chief Assayer to the Mint in Bombay, 1940-1946, Director of National Government Test House in Calcutta 1953-1956. He was Deputy Director General of the Indian Standards Institution 1956-1966, and its Director General, 1966-1971. In 1946-1948 he was Research Metallurgist to the Indian Standard Metal Company, Bombay, and in 1948-1953, Director of Metallurgical Research and Planning to the Government of Burma. He has long been active in both the International Standards Organization and the International Organization for Legal Metrology.

Hall, Newman A.

Born in Uniontown, Pennsylvania in 1913, Dr. Hall received his Ph.D. (Mathematics) in 1938 from the California Institute of Technology. During World War II he was an engineer with United Aircraft Corporation and head of the thermodynamics group in the Research Department. He was Professor and Chairman, Mechanical Engineering, Yale University, 1956-1964, and is now with the National Academy of Engineering as Executive Secretary in the Office of the Foreign Secretary. He has been active in both U.S.A. and international standardization programs for over twenty-five years.

Hayes, Jerry L.

Mr. Hayes is a Mechanical and Electronic Engineer, educated at the University of California, Berkeley. He is Technical Director of the U.S. Navy Metrology Engineering Center--a technological center providing guidance, equipment, training, and support to a network of 400 Navy calibration laboratories. He is also President of the National Conference of Standards Laboratories and Chairman of the U.S. Department of Defense Calibration Coordination Group.

Huntoon, Robert D.

Dr. Huntoon was born in Waterloo, Iowa, in 1909. He received a B.A. from Iowa State Teachers College in 1932; M.S. and Ph.D. in nuclear physics from State University of Iowa in 1938. He was an Instructor in Physics, New York University in 1940; a Research Physicist with Sylvania Electric Products in 1941. He came to the National Bureau of Standards in 1941, serving in Electronic Ordnance, in the Atomic Physics Division, as Associate Director of Physics; as Deputy Director; and from 1964 until his retirement in 1968, as Director of the Institute for Basic Standards.

Kalmanoff, George

Mr. Kalmanoff, born in New York City in 1917, is Deputy Director of the Industrial Projects Department of the World Bank, and has been with that agency for the past five years. His earlier career included some ten years of service in the U.S. Government; three years with the U.N.; six years as an economic advisor in residence in Bogotá, Colombia; and seven years at Columbia University co-directing research projects and co-authoring books on Joint International Business Ventures and International Financial Aid. He was educated at the College of the City of New York and at American University in Washington, D. C.

Knox, William T.

Mr. Knox, a research chemist and chemical engineer with ESSO Research and Engineering Company from 1938 to 1957, was later Director of its Technical Information Division and Manager of Corporate Planning. In 1964 he joined the Office of Science and Technology in the Executive Offices of the President, with responsibilities for scientific and technical information. From OST he went to McGraw-Hill, Inc. as Corporate Vice-President for Information Systems. In 1970 he joined the Department of Commerce as Director of the newly-created National Technical Information Service.

Kushner, Lawrence M.

Dr. Kushner was born in New York City in 1924, received a B.S. in Chemistry from Queens College, New York and a Ph.D. in Physical Chemistry from Princeton University in 1949. Dr. Kushner has been at the National Bureau of Standards since 1948, engaged in research and administration in the areas of metallurgy and colloid chemistry. Currently he is the Deputy Director of NBS and Chairman of the Scientific Research Society of America.

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Dr. LaQue was born in Ontario, Canada in 1904, and graduated from Queen's University, Kingston, Ontario in 1927. He has worked for the International Nickel Company since 1927 retiring as Vice-President in 1969, and continuing as a consultant. He served as President of the American National Standards Institute in 1969-1970, as President of the American Society for Testing and Materials in 1959, and is now Senior Lecturer, Scripps Institution for Oceanography, La Jolla, California. He is currently President of the International Organization for Standardization (ISO) and Vice-President of the Pan American Standards Commission (COPANT).

Lartey, Emmanuel

Mr. Lartey, born in Ghana in 1921, holds the academic degrees of B.Sc. in Engineering from London University, and M.S. from Northwestern University, Evanston, Illinois, and the professional degrees of FICE in U.K. and MASCE in U.S.A. After some years as Engineer-in-Chief, Public Works Department, Ghana, he is now Director of the Institute of Standards and Industrial Research.

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Mrs. LeRoux, a Chemical Engineer, graduated from the National University of Engineers at Lima, Peru, in 1949. She has worked at the Ministry of Public Works and in private industry. During 1957-1958, she was at the French Standards Association (AFNOR). Since 1961, she has been Chief of the Standardization Division at the National Standards Institute in Peru, now called the Technological Industrial Research and Standards Institute (ITINTEC).

Maia, Geraldo N.S.

Born in Rio de Janiero, and educated in the Naval Academy there, Admiral Maia served in the Brazilian Navy in 1968, was Deputy Director of the Navy Research Institute, and retired to become a private consultant. His graduate work at the Massachusetts Institute of Technology earned him both an M.S. and an M.Eng. In 1967-1968, he was a member of the National Research Council of Brazil, and participated in its joint study with the National Academy of Sciences, U.S.A., looking to a system of national scope covering governmental and private activities able to meet Brazil's requirements in the areas of standardization and compliance tests.

Marshak, Seymour

With a B.S. from Temple University, Philadelphia, Pennsylvania, in 1948 and an M.B.A. from the University of Michigan Graduate School in 1949, Dr. Marshak began teaching at the University of Detroit, and subsequently earned the Ph.D. at the New York University Graduate School of Business. He taught Marketing at Rider College and de Paul University, and from 1957-1961 was Vice-President of National Analysts, Inc. of Philadelphia. Since 1961 he has been Marketing Research Manager for the Ford Motor Company, Dearborn, Michigan. His professional activities include service on the National Industrial Conference Board.

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Mr. Nigro was educated at the University of Maryland and the Georgia School of Technology. He served in the U.S. Navy as an aviator and completed his duty as a Section Chief in the Office of Naval Research, Special Device Division, responsible for the design and procurement of flight simulators. He joined the National Bureau of Standards in 1947 and has participated in guided missile development, automated production of electronic assemblies, and in "Tinkertoy" and computer development. He is currently Chief of the Information Processing Technology Division, Center for Computer Sciences and Technology.

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Born near Berlin, Germany in 1917, Mr. Peiser became a citizen of the U.S.A. in 1963. He attended St. Paul's School in London, and took his B.A. and M.A. at Cambridge University. During 1941-1947 he worked for Imperial Chemical Industries, the Atomic Energy Research Establishment, and the Nuffield Cement Research Laboratory. After teaching at London University, he became head of metal physics research at Hadfields Ltd, and principal scientist at the Aeronautical Inspection Directorate's Test House.

In 1957 he joined NBS, and after heading first the Mass and Scale Section and later the Crystal Chemistry Section, became Chief of the Office of International Relations and Manager of the NBS Foreign Currency Program. Diverse scientific missions have taken him to Malaya, Japan, China, Korea, Vietnam, India, and Israel. Basically he is an x-ray crystallographer, and is Secretary of the IUPAC Commission on Atomic Weights.

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Dr. Perkinson was born in Etowah, Tennessee in 1914, and earned a B.S. at the University of Tennessee. His Ph.D. in biochemistry came from the University of Rochester in 1943. He was a senior scientist at the Oak Ridge Institute for Nuclear Studies 1949-1952, taught at the University of Tennessee Medical School 1952-1957, worked for the U.S.A. Atomic Energy Commission 1957-1958. Since 1958 he has been with the Organization of American States as Director of the Department of Science and Technology, and Executive Secretary of the Inter-American Nuclear Energy Commission.

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Mr. Pratt graduated from the University of Colorado with a degree in chemical engineering. Before joining the Monsanto Company 15 years ago, he held supervisory positions in the plant manufacturing and operating activities of the duPont Company in Texas and Ohio. He began his career with Monsanto at Texas City, Texas, and then was assigned overseas as plant manager and director of engineering in Monzon, Spain, and later to Barcelona, where he was director of manufacturing with a Monsanto-affiliated company there. Mr. Pratt is now Director of Manufacturing and Technology for Latin America at the Monsanto Company world headquarters in St. Louis.

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Dr. Probine was born in Auckland, New Zealand in 1924, took undergraduate work at Auckland and Wellington Universities, and earned a Ph.D. in Physics at the University of Leeds, England. He is a Fellow of the Royal Society of New Zealand, the author of some 20 scientific papers, and currently the Director of the Physics and Engineering Laboratory of the New Zealand Department of Scientific and Industrial Research. In 1970 he completed a major assignment for UNESCO by compiling a detailed list of the facilities for basic physical standards of weights and measurement in South East Asia.

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Dr. Rohatgi was born in Kanpur, India in 1943. He received his undergraduate degree in India and the doctorate in metallurgy from the Massachusetts Institute of Technology in the U.S.A. He was a research metallurgist with the International Nickel Company for four years and then spent one year as a visiting faculty member at the Indian Institute of Technology at Kanpur, India. Presently he is with the Homer Research Laboratories of the Bethlehem Steel Company. He has authored about twenty technical papers in the field of metal solidification and foundry technology. The American Foundrymen's Society gave him the award for the "best work in 1969" in the area of light and reactive metals, for developing cast composite alloys.

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Mr. Russek holds a B.S. in Engineering from the University of California at Los Angeles, where he majored in systems engineering. With 17 years in the Aerospace Group at Hughes Aircraft Company, he now manages a section involved in the sale and performance of test equipment, notably in support of the metrology and calibration activities of the Department of Defense.

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Dr. Salama was born in Cairo in 1915; received a B.Sc. (Hons) in 1937 and Ph.D. (analytical chemistry) in 1944 from Cairo University. As Undersecretary of State for Industry in the United Arab Republic and Chairman of the Egyptian Organization for Standardization, he added significantly to international councils in metrology through the International Organization for Legal Metrology. As Secretary General for the Arab Organization for Standardization and Metrology (ASMO), he must be congratulated to have achieved a truly international metrological organization on a regional basis.

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Mr. Smith, a native of Dayton, Ohio, received his B.S. in chemical engineering from Purdue University in 1936. He has been employed as a process engineer, as a foreman of heat treating, as a metallurgist, and as a standards engineer. Since 1951 he has held the position of Director of Engineering Standards for Reynolds Metals Company. He has been active in ASTM since 1945, and in 1963 received the ASTM Award of Merit for his work in the field of light metals. Since 1963 he has been chairman of the U.S.A. National Committee for ISO/TC79 and has headed the U.S.A. delegation to the international meetings.

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After having served as a consultant to the petroleum industry and as an Associate Professor of Engineering, Dr. Stepanek joined the United Nations (UNRRA) staff in Shanghai, China in 1947 as Associate Director of the Agricultural Industry Service. This service adapted modern technologies for the special needs of manufacturing and processing companies in China.

After leaving China in late 1949 and through 1967 he led industrial development teams or served as a consultant on industrial development problems in over 20 countries in Asia, Latin America, Africa and the Middle East, under programs financed by the United Nations, the Ford Foundation, or the U.S. Government. During 1957-1958 he was a consultant on the staff of the United Nations Bureau of Economic Affairs in New York and for an additional year worked with an industrial research group at Stanford Research Institute. In 1968 he joined the United Nations Industrial Development Organization (UNIDO) in Vienna as a Special Technical Adviser to the Executive Director and since 1970 has been Director of the Industrial Services and Institutions Division of UNIDO.

Tabor, Harry

Dr. Tabor, a physicist, received his B.Sc. from London University and his Ph.D. at the Hebrew University of Jerusalem. He was involved in research and development in instrumentation up to 1949, then went to Israel where he joined the National Research Council and set up the National Physical Laboratory of Israel which he directs. His own field of research is in energy conversion, in which field he has an international reputation having advised to UNESCO, ECOSOC, ECA, WMO, and the governments of several developing countries.

Tam, Phi Minh

Mr. Phi Minh Tam is a graduate of the New York State University College of Forestry at Syracuse. He did his graduate study in chemical engineering at Massachusetts Institute of Technology, but he was recalled by his government to serve in war-torn Vietnam which badly needs men and women with his kind of training. Appointed Chief of the Chemical Industry Section of the Industrial Development Center he helped elaborate and evaluate industrial projects and assisted in the implementation of many of the existing manufacturing plants. In 1967, Mr. Tam was commissioned by the Ministry of Industry to organize and head the newly erected Vietnam Institute for Standardization. Recently ground was broken for the construction of a testing laboratory with the contributions of local manufacturing and technical associations, and Mr. Tam expects his Institute to begin to provide testing and calibration services to the industrial sector at the beginning of 1972.

Willenbrock, F. Karl

Educated at Brown and Harvard Universities (Ph.D. in electron physics 1950), Dr. Willenbrock served at Harvard as faculty member 1950-1967, Director of Laboratories 1960-1963, and Associate Dean of Engineering and Applied Physics 1960-1967. In 1962 he was given the Distinguished Engineering Award of Brown University. While Provost of the State University of New York at Buffalo, he served as President of the Institute of Electrical and Electronic Engineers (1969). He headed a delegation of engineers to the Soviet Union, and represented the U.S.A. at the World Federation of Engineering Organizations in Paris. His appointment as Director of the NBS Institute of Applied Technology came in 1970.

Work, Harold K.

Dr. Work was born in Connecticut in 1901, and took his A.B. and Ch.E. from Columbia University in 1925, and his Ph.D. in chemical engineering from the University of Pittsburgh in 1929. He was employed by the Aluminum Company of America 1929-1934, was Manager of Research and Development for Jones and Laughlin Steel Corporation 1936-1949, and was Director of the Research Division of the New York University College of Engineering 1949-1966. In 1964, he became Secretary of the National Academy of Engineering, and in 1968 he went to Iran for the UN as research advisor to the Institute for Standards and Industrial Research.

APPENDIX 9

AUTHOR INDEX

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APPENDIX 10

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16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)
The National Bureau of Standards held a 4-day Seminar in an effort to learn how its experience in metrology and standardization for the science and technology of U.S.A. might be used most effectively for less developed countries. With financial support of the Agency for International Development, participants came from Argentina, Brazil, Ethiopia, Ghana, Guatemala, India, Israel, League of Arab States, New Zealand, Peru, and Vietnam; from several international agencies; and from industries, professional societies, and government in U.S.A. The papers presented and the informal discussions were organized around the session titles:

Perspective
The Sociological, Economic, and Managerial Environment in Industrializing Countries
Making Scientific and Technological Measurement Meaningful
The Dissemination of Information
Promoting More Effective Use of Science and Technology
Additional Case Histories
Promoting Economic Strength and Commercial Equity
Guidance for NBS Technological Assistance Effort

It was concluded that industrializing economies would benefit from NBS activities in these fields, and specific suggestions were offered to that end.

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