Technology and World Trade

PROCEEDINGS OF A SYMPOSIUM

U.S. DEPARTMENT OF COMMERCE / NATIONAL BUREAU OF STANDARDS

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Technology and World Trade

PROCEEDINGS OF A SYMPOSIUM

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Secretary of Commerce of the United States
on the Occasion of the Dedication of the
New Laboratories of the National Bureau of Standards
at Gaithersburg, Maryland

U.S. DEPARTMENT OF COMMERCE
John T. Connor, Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

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Robert L. Stern

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Symposium on TECHNOLOGY AND WORLD TRADE

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Program Chairman: Robert L. Stern

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A Symposium:

■ To **examine** and forecast the impact of technology upon the patterns and conduct of international trade and investment

■ To **consider** the international environment needed for the wider generation and utilization of technology

■ To **explore** prospects for evolving policies and institutions that promote economic development through technology and trade

November 16, 1966

INTRODUCTION

Mr. Stern: Mr. Secretary, Honored Guests, Ladies and Gentlemen: Good morning to you on this brisk fall day.

ROBERT L. STERN
Program Chairman
Chief, Office of Industrial Services
National Bureau of Standards

The ship "Technology" is about to set off on a round-the-world cruise. Our adventure and exploration during the next two days takes the form of a symposium which, to recall the definition of the Greeks, means: a feast, a gathering together with free exchange of ideas, a drinking together. Each aspect of this definition will have its place in these proceedings.

Now, to get under way, and to introduce the Sponsor of the Symposium and later the Chairman of this morning's session, I would like to present Dr. J. Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology.

Dr. Hollomon: Honored guests, friends from Washington, New York, Delhi, Madrid, Ottawa, Paris, and Manila and a dozen other world capitals, welcome! One of every six or seven of us is a visitor to the United States. At least 25 nations are represented here.

No matter where you came from, technology helped bring you here. Many of you used jet airplanes. All of us used automobiles or buses. Transportation technology contributed to bringing us here, I hope quickly, comfortably and safely.

We are meeting in facilities built with a great deal of technology and we are using the products of technology to hear and see and record our findings. The specific occasion which brings us together is the dedication of this magnificent new facility. We are also commemorating the sixty-fifth anniversary of this great scientific and technological institution—the National Bureau of Standards, an agency of the United States Department of Commerce.

We all owe a debt to technology. We can partially repay that obligation by making our two-day discussion effective, pointed, stimulating, and helpful to one another.

We planned this symposium so that you will have ample opportunity at each session for questions from the floor. We are also providing two luncheon sessions and a banquet and at that banquet the Vice-President of the United States will speak to us. We hope that will encourage you to recognize that this is a symposium of people talking together, rather than a few of us talking to all of you.

We believe that technology, appropriately understood, morally and ethically applied, is the best hope for a peaceful, prosperous society. Technology does not automatically flow to where it is needed. It is necessary that men spend their wills and their hearts to bring technology to people in a way that will contribute to their progress, their health, and their well-being.

For the opening remarks on these subjects, we are privileged to hear the Sponsor of this conference, the distinguished Secretary of Commerce of the United States, the Honorable John T. Connor.

J. HERBERT HOLLOMON *became Assistant Secretary of Commerce for Science and Technology in May 1962, having been nominated by President Kennedy and confirmed by the Senate. In this position he supervises the Patent Office; the National Bureau of Standards; the Environmental Science Services Administration; and the Office of State Technical Services.*

He also is the principal advisor on scientific and technical matters to the Secretary of Commerce, and he is a member of the Federal Council for Science and Technology, consultant to the President's Science Advisory Committee, and Chairman of the Interdepartmental Committee for Atmospheric Sciences.

Dr. Hollomon was with the General Electric Company for 18 years, as metallurgical researcher, Manager of Metallurgy and Ceramics Research, and General Manager of the General Engineering Laboratory.

JOHN T. CONNOR *was nominated Secretary of Commerce by President Johnson on January 6, 1965, and confirmed by the U.S. Senate on January 15. He assumed his cabinet post after a career of law, government and industry, which spanned a quarter of a century since his graduation from Harvard Law School in 1939.*

He is a graduate of Holy Rosary High School in Syracuse, New York; of Syracuse University where he received his A.B. degree, magna cum laude; and Harvard Law School where he received an LL.B. degree in 1939. Mr. Connor then was associated for several years with the New York City law firm of Cravath, de Gersdorff, Swaine and Wood.

In 1942, Secretary Connor was appointed General Counsel of the Office of Scientific Research and Development, of which Dr. Vannevar Bush was Director. In 1944, he went on active duty with the U.S. Marine Corps, serving in the Pacific as an air combat intelligence officer. Returning from Japan in 1945, he became Counsel to the new Office of Naval Research, and later, Special Assistant to Secretary of the Navy James Forrestal.

Mr. Connor joined Merck & Co., Inc., in 1947 as general attorney and held several other key executive positions before being elected president of the company on September 27, 1955. In February 1967, Mr. Connor returned to private industry and became President of the Allied Chemical Corporation.

OPENING STATEMENT

Technology and Management As Instruments of World Progress

Secretary Connor: Thank you, Dr. Hollomon. Honored guests, ladies and gentlemen: I am pleased to welcome all of you to this symposium on technology and world trade. Many of you have come a great distance to participate in this dialogue. I am confident that when we are finished our efforts will be repaid with a clearer view of the common problems we face in the global exchange of goods, services, commodities, knowledge, attitudes, and ideas.

At the dedication of these magnificent facilities yesterday, President Johnson sent a special message of greeting. He noted that the symposium would open here today and expressed his confidence that the ideas emerging from this symposium will provide a fresh insight into the task of creating a life of abundance for people everywhere. Technology and world trade are vital elements in the economic life of all nations in the shrinking world and accelerating times of today.

The National Bureau of Standards and the Department of Commerce

This symposium is especially appropriate at this time, coinciding with a momentous event in the history of the National Bureau of Standards. The Department of Commerce is charged with helping create those conditions which will encourage and stimulate the growth of the national economy. The National Bureau of Standards is a charter member of the Commerce Department, having joined us when the department was established more than half a century ago. NBS is also the nation's measurement laboratory, our spokesman in the international language of science, a center of research, technology, and its application.

The dedication of these new laboratories occurs as the Bureau is placing increased emphasis on several fruitful areas of cooperation with American business and industry. International standardization of industrial products, the development of performance criteria for technological goods and services, methods for measuring the performance of entire systems, and the dissemination of scientific data and technical information—these activities all have great relevancy to international trade.

From the earliest days of its planning, I have sensed an air of excitement about this particular symposium. For this reason, I don't want to delay your exchange of ideas and opinions for one minute longer than necessary. In this setting, sequestered from the day-to-day considerations of immediate problems, perhaps we can suspend the old dogmas and construct an edifice of new ideas, beginning from the ground up. I would like to take a few minutes at the beginning to examine with you some of the foundation stones on which your dialogue can be based. These fundamental notions are axiomatic to the specialist. To a nonspecialist, such as myself, they sometimes provoke more questions than they provide answers.

Purposes of the Symposium

This symposium has three purposes: First, to look at the impact of technology upon international trade and investment. Second, to outline a world environment which will encourage more widespread use of technology. And, third, to seek new ways for technology and trade to promote economic development.

These objectives combine to create a formidable challenge. Fortunately, you and your speakers are admirably qualified to come up with constructive answers.

Fortunately, our constitution created a union of states and precluded any attempts to raise trade barriers between one state and another within the United States. As a result, this early common market grew into a mass market with economies of scale which contributed immensely to our economic growth and our technological development.

In spite of this favorable environment, however, we have not yet achieved a nationwide parity in standards of living or in the level of technological development. The Appalachian region of America stands in stark contrast to areas on the East and West Coasts, both economically and technologically.

Through our system of agricultural colleges, research stations and farm specialists scattered throughout the nation, the dissemination of the latest agricultural technology has become a successful reality in this country. We have not yet been so successful in the manufacturing and service sectors of our economy. Studies conducted by the Commerce Department show that there is a wide area of difference, a wide range of difference, between the most efficient and the least efficient plants in any given industry. This pattern exists regardless of the size of the plant, and this condition is true whether it is a labor intensive industry or a high technology industry. In some industries, the value added per employee in the most efficient plants is five hundred percent above the amount for the least efficient plants.

Think of the competitive advantage this offers the top firms. Or on the other hand, think of the waste in human and material resources among the lowest firms. These efficiency gaps include many components—management skills, availability of capital, marketing know-how, participation in world trade, condition of plant and equipment, flexibility of labor and management, ability to utilize the latest technology, and many, many others.

Our economists estimate that if all companies in all industries followed the most advanced practices and techniques of the most efficient companies, the growth in national productivity would greatly exceed the growth rate of recent years. Practically speaking, this may be expecting too much, but it is clear that there exists a great potential for improvement.

Opportunities for Better World Use for Technology

Looking at the broad problems of technology and trade from a global point of view, what needs to be done? More to the point, what can be done?

First, there are some institutional goals we could work toward. These include such things as greater participation by all countries in the development of international standards for industrial products, an accelerated and more broadly based movement toward some form of international patent cooperation, an unfettered flow of capital among nations with due provision made for special circumstances and special cases, the reduction and elimination of barriers to trade on a fair and reciprocal basis, wider availability and movement of technology among nations.

Second, we need to change our approach to the fact that there *are* differing levels of technology in various fields among the nations of the world. Our thoughts and actions should not be directed toward compensating for these differences artificially. Rather we should try to assure that each nation has access to the particular technology most appropriate to its own goals as defined by that nation. In this way, trade and economic growth will both be enhanced.

Third, we need to know more about the processes of technology, trade and economic growth, how they interact, why a certain formula succeeds for one country and fails in another. Toward this end, the United States has joined with the member nations of the OECD in a major study of the processes by which nations are able to develop and exploit science and technology for the attainment of economic and other national goals.

The results of this study should be useful to all nations and applicable to all levels of development.

Can these objectives be realized? I don't know of any substantive reason why they cannot, if we have the will to succeed and a willingness to cooperate. The United States stands ready to join with all other countries in efforts to disseminate and use the knowledge of mankind for the benefit of mankind.

November 16, 1966

Morning Session—Technology: Its Influence on the Character of World Trade and Investment

Dr. Hollomon: I should now like to introduce to you Dr. Frederick Seitz, the President of the National Academy of Sciences, who will be the chairman for this morning's session.

Dr. Seitz: Thank you, Dr. Hollomon. Our session deals with technology in world trade, as has been made clear. I would like to say a few words of introduction about both.

Technology in Human History

Man is innately a technologist—inherently inventive. This characteristic is part of his birthright and is linked intimately with the constitution of his genes. The long road of evolution of our species over the past million years is in fact littered with the products of our inventive technology. There is much direct evidence for the crude tools of stone our forebears have produced and much indirect evidence for those made of wood and bone.

When our species emerged about 50,000 years ago with its present genetic make-up, more sophisticated devices appeared, including arrows, spears, axes, hooks, nets, and intricately woven objects. The basic genetic equipment which made us technologists is well known. This includes manual dexterity, stereoscopic vision and the ability to reason. Armed with these attributes and the willingness to focus attention on issues of immediate practical importance, our antecedents moved ahead, first as hunters and food-gatherers and then, about 10,000 years ago, as agronomists. Five thousand years ago we became masters of the great river valleys which yielded such riches that it became possible to develop professional specialization, including most of the fields of modern engineering.

Between one thousand and fifteen hundred years ago those of our ancestors living in Northern Europe learned to cultivate the soils of the temperate climate and to develop the technology associated with that climate. This advance in technology, in turn, made the urban revolution possible in northern latitudes. Without such a revolution the settling of North America would have been of little meaning to mankind, except for the access the discoverers might have had to the natural raw materials of the new land.

Science Revolutionizes Classical Technology

About 500 years ago, the earnest, practical philosophers of Western Europe conceived of an entirely new basis for technology. Inspired by access to the manuscripts of Greek science, they conceived of establishing a new form of technology which would extend well beyond the scope of classical technology and which would rest upon investigations of the basic laws of nature. In brief, they recast ancient science into a new form and evolved what we now call modern science—a process designed to gain knowledge of nature characterized by the careful interplay of *observation* and *theory*. It took time for the dream of these philosophers to be realized. However, starting about 170 years ago with the dawn of the age of modern chemistry—a product of the scientific method—a great scientific revolution in technology was set into motion. It is easy to show that by the present time technology would have been running out of momentum if it did not have the contributions of science. By the end of this century the methods of classical technology would have proved to be stagnant.

The Impact of Trade on Technology

Historically, as Secretary Connor pointed out so eloquently, the evolution of technology has been very closely coupled with the development of trade. Once man became a trading animal, as he did very early—at least 10,000 years ago—he began to trade technology along with material objects. This not only stimulated his own process of technical innovation, but also made him aware of the importance to his own welfare of the acquisition of alien methods of technology. The interchange of technology has in fact been as important a component of trade as the interchange of material products. Trade not only brought British tin to the Mediterranean, but stimulated the entire technology of producing tin alloys. The trade with China, initiated by the Chi-

FREDERICK SEITZ *is the first full time President of the National Academy of Sciences, a position to which he was elected in 1965 for a six-year term. He served the previous three years on a non-resident basis while continuing his affiliation with the University of Illinois. There he was most recently Dean of the Graduate College and Vice President for Research. Earlier he headed the Physics Department for seven years, following an extended period as Research Professor of Physics. He taught at the Universities of Rochester and Pennsylvania, and at Carnegie Institute of Technology. He also spent two years with the General Electric Company.*

Dr. Seitz, a native of San Francisco (1911), California, received his A.B. in Mathematics from Stanford University (1932), earning his Ph.D. in Physics at Princeton two years later.

Dr. Seitz is presently a member of the President's Science Advisory Committee and of the Statutory Visiting Committee for the National Bureau of Standards.

Dr. Seitz is Vice President of the International Union of Pure and Applied Physics, and a member of the Committee on Science and Technology in Developing Countries of the International Council of Scientific Unions.

nese, not only brought Chinese textiles and ceramics to the West, but stimulated a host of parallel developments in the corresponding fields of technology in the Mediterranean. Our own trade with Europe and Asia accelerated our national development not only through the import of materials, but also by stimulating our own technology. Our own technological advances have, in turn, had a very deep influence on the parts of the world with which we trade.

Technology based upon science developed very slowly in our country. It was, in fact, only in this century that we accepted broad responsibility for generating science-based technology. Earlier in our history we were in the main acquirers of products or of licenses stemming from science-based technology generated elsewhere. Interestingly enough, the stimulus for the reform came less from scientific scholars than from the leaders of industry who desired to make their products competitive throughout the world. In fact, the establishment of the great industrial laboratories, such as those of the General Electric Company, the Bell Telephone Company, and du Pont, near the turn of the century can be regarded to represent the dawn of a genuinely new era in our own technological history.

If one tries to characterize the various phases in our history of creative technology, one can perhaps say that our period of innovation in the pattern of classical technology reached its climax in the era of Thomas Edison. The revolution associated with the computer is the first major product of our creative association with science-based technology.

Dr. Seitz: With this background of historical observations on man's relationships with technology and trade, I would like to introduce our next speaker on the morning session, Dr. Marshall McLuhan. Dr. McLuhan is Director of the Center for Culture and Technology of the University of Toronto, Canada.

Dr. McLuhan: Mr. Secretary and ladies and gentlemen: The environment you have provided for us makes an occasion to relate to you one of our Canadian cultural products—French-Canadian grievance humor. Have you ever noticed that good jokes tend to record grievances? The grievances of the French-Canadians have been much related to the electronic age, in which they feel a new need for separation and decentralism, and some of the stories that go with that are of this grievance type.

A mouse is being pursued around the house by the cat and finally discovers a hole in the wall where it hides. And then all is silent until a kind of bow-wow, arf, arf, sound is heard. The mouse figures the house dog has come along, scared the cat away, and ventures out. The cat grabs it and as the cat chews the mouse down, it says, "You know, it pays to be bilingual."

Another Canadian contribution to this grievance humor is the sign that hangs over a junkyard in Toronto which reads, "Help beautify junkyards. Throw something lovely away today."

It is a very rich observation.

There are quite a lot of these grievance stories, which are rather instructive, but I am going to venture a few themes here in relation to our very rich subject of technology and world trade.

The New Environment for Man

I suppose one could simply sum the whole thing up and say that any economy is an information pool and, under electronic conditions, the world is a single information pool; therefore, there can and must be just one economy. As the world becomes a total information pool, and therefore simultaneous, the natural tendency is for all the older patterns and barriers and structures to be swept aside.

I think one might safely predict, for example, that with the coming of the satellite environment for our planet, the planet is no longer the human habitat.

The planet is now the content of a man-made environment of electric information and satellite information. When the planet itself goes inside a man-made environment, the planet becomes as it were, an old nose cone, an art form. Every time a new

MARSHALL McLUHAN *is Director of the Center for Culture and Technology at the University of Toronto. Prior to this, he was Professor of English at that University's St. Michaels College, and earlier held teaching assignments at Wisconsin University, St. Louis University and Assumption College.*

A native of Edmonton, Alberta, Canada, Dr. McLuhan obtained his Bachelor's and Master's Degrees in Arts from Manitoba and Cambridge Universities, then receiving his Doctor of Philosophy degree at Cambridge in 1943.

Dr. McLuhan is the author of several books, including "The Mechanical Bride: Folklore of Industrial Man," "Understanding Media" and "The Gutenberg Galaxy." He has in addition contributed to numerous periodicals including "Daedalus," the "Kenyon Review" and other literary magazines.

environment of any sort goes around another one, every time a new technology creates a new environment, that environment goes around the environment of the preceding technology, turning the old technology into an art form.

Environments need to be understood as processes. They are not containers, they are processes. So when the TV environment went around the old movie environment, the movie industry became increasingly an art form. The process of the TV surround has turned increasingly the old movies into art form, and this now is happening to TV itself with the satellite environment going around TV.

I suppose, too, it is natural to observe that in the age of the circuit, the electric circuit, with its feedback and folding back into itself, we have come to the end of the neolithic age, the age of the planter, the strip culture, with each person mining his own bit of knowledge. With the diffusion of knowledge instantaneously, in all sorts of patterns simultaneously, a great diversity of patterns, we have come to the end of the neolithic time.

But the strange thing is this, that we have flipped, as it were, back into the age of the hunter. The electronic age is once more the age of the hunter, only it is now the hunt for information, for data. The image of Sherlock Holmes and of James Bond offers (again) the age of the hunter.

Reversals and the World Information Pool

This aspect of our time merely points to a number of other reversals and flips that are upon us technologically.

For example, with the coming of xerography and electric circuitry to the book trade, a typical type of reversal that is manifest in many other fields has set in. Instead of the book being a repeatable commodity, a package—and it was the printed book that was the first uniform, repeatable commodity, making possible markets and prices as we know them—the book tends to be an information service.

The book can be programmed for the individual request—tailor-made, custom built. The tendency of circuitry and electronic movement of information is to break up the old patterns of mass production and uniformity into the custom-built service.

As we create these new and revolutionary situations, it is typical that we go on talking about the old situation as if it were still the dominant one.

With xerography as a service, it is possible, for example, to form an electrical information center. Say I am working on Egyptian arithmetic and I would like all the most recent material. I read such and such, I know such and such languages, and in a few minutes or hours, a package is gathered from all the libraries in the world and can be delivered to my door. The book is becoming, with the aid of the computer and the telephone and Xerox, a completely flexible service.

This pattern, for example, as it enters the world of education, means that instruction in the older classroom sense will tend to yield, as it is already yielding, to discovery as a technique of learning. The older pattern of imposing knowledge or instruction upon the young is steadily yielding to the pattern of discovery as a means of learning.

Our dropout situation is not unrelated to this. Many children have the feeling that by being sent to school, their education is being interrupted.

Because we—literally—live in a world in which the outside environment is far richer in information than the schoolroom.

Pattern Recognition and Information Overload

Jacques Ellul, the French philosopher of technology, observes that: "The Twentieth Century child is engaged from morning to night processing data, on a massive scale." You might ask yourself, what happens when we subject children to massive doses of man-made environment, what happens to their outlook, their inlook and their outlook?

One thing that happens is that under conditions of informational overload, which is normal, they develop patterns of mythic thinking, because it is only by mythic thinking that you can cope with information overload. Pattern recognition is another name for mythic thinking. Instead of just acquiring data, you have to discover patterns in order to survive.

There is a well-known story by Edgar Allen Poe. It is called "THE MAELSTROM"—about a sailor who goes fishing one afternoon and becomes so absorbed in his thought that he forgets to notice the turn of the tide and suddenly is caught in a great whirlpool. He realizes he can't row his boat out of the maelstrom and so he begins to study the action of the maelstrom. He observes that certain kinds of materials are sucked down into it and never return while other kinds pop up again. He attaches himself to one of these recurring objects and survives. This is pattern recognition. My point is: to understand the *process* is an indispensable way of coping with information overload.

But there are some other points I want to introduce, apropos of the creation of huge new environ-

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ments by technologies. One of the peculiarities we discovered lately when we began working on this problem of pattern recognition, is that whenever a new environment forms, it is invisible and what you perceive is the old environment.

I think it was Bertrand Russell who asked, if bath water were to get hotter one degree per half hour, would we ever be able to scream. Would we ever know to scream before we were completely boiled? The answer is no, we wouldn't, and it is apparently quite possible to boil fish alive by simply raising the temperature slowly almost imperceptibly.

Each of us forms a body percept, from moment to moment, based upon his intake of sensations, perceptions, but we are completely unaware of this body percept which we form of ourselves from moment to moment. It takes considerable dexterity and skill to observe one's own body percept, the image we form of ourselves. The immediate surrounding—the new environment, whatever it is—is always invisible to the whole population.

Navigating with the Rear-View Mirror

What they see in the mirror is the old environment. When the railways were new on this continent a century ago, the people of that time formed an image of their new industrial iron horse environment that was the Jeffersonian ideal of agrarian pastoral life.

Modern suburban man lives in the rear view mirror of "Bonanza." He perceives not suburbia but "Bonanza life." That is the old environment, the preceding environment, a world of compassion, initiative, and resourcefulness, a comfortable form of the frontier. Very picturesque!

The habit of always using the rear view mirror for navigation is now yielding because at jet speeds the rear view mirror has proved to be a somewhat unreliable device. But, also at very high speeds, it becomes possible to recognize environments that were previously not noticeable.

The Effects of the Electric Technology

And so the advantages of high speed change is in the recognition of forms that previously had been imperceptible. If education is undergoing the flip from instruction to discovery or tending that way, there are other extraordinary flips resulting from technological advance. There is a general tendency to use the audience as a work force instead of as a target or consumer. One of the strange results of the speed-up in information processing and speed-up of access to information is that the total audience can become involved in decision-making.

The idea of having an audience as work force, in politics and in business, is perhaps foreshadowed in the advertising world, where for some time now a new environment has been forming.

As information processes improve, the advertising world is steadily substituting itself for the products; that is, people now derive their satisfactions not from the product but from the advertisement.

You see, the research of the advertisers has long revealed to them that the people who read ads are people who own the things, not the people who should or might buy them. People read ads as a source of satisfaction, consumer satisfaction. In an electric information environment, the ad is steadily replacing the product. And this isn't really paradoxical. It is what we have been working to achieve for a long time.

The programming of the human environment by information, the total programming of the human environment by information, is more and more within reach with satellite broadcasting. You can now program the world environment as a single shared experience. As information levels rise and improve, we share the experience of this planet as a single thing with everybody.

These are huge flip-overs or reversals that naturally tend to be hidden simply because they are of such vast environmental form, and you may wish to discuss them.

One of the flips that exists now in the age of the computer is that it becomes possible to enter a cashless society. By use of the credit card, it is possible to effect all type of transactions without any form of cash whatever. And when it becomes possible to do something, there is usually a kind of restless itch until something is done about it.

I am going to mention one further flip-over that is taking place in our own homes, under our own noses, and with great disturbance in our lives, but without any recognition of the pattern.

With the coming of the circuit, man folds back into himself. With the coming of television, man becomes, instead of camera going out into the world, man becomes screen.

Our children for the last ten years have had the extraordinary experience of growing inside themselves with television. They are on the receiving end of that electric charge. It carries them inside themselves through the looking glass into a world, through the vanishing point into a kind of inner meditative world.

The effect of television has been to orientalize the Western world. This is so vast a program or reprogramming of the sensory life as to be completely unobserved. But, while we are busy westernizing the East, we are hastily easternizing the West.

Our children regard parents who belong to the old Western civilization as finks, as squares, simply because they are put together on a different pattern from the pattern that children take for granted, of inner depth and commitment.

A young friend from Harvard was saying the other day, "*We* are not a goal-oriented generation." He is a young architect. He said, "Sure, we'll learn medicine, we'll learn architecture, but we wouldn't dream of setting ourselves a *goal* in life and moving steadily toward it."

He said, "What we want is to know what is going on in the total human environment. We're not a goal-oriented generation."

The hunter isn't a man with a goal. He plays the total field, and I think electronically we are compelled to develop our perception and our awareness this way if we are going to exert any sort of control over the next changes in the world.

The Hot and the Cool

We might ask ourselves to what extent would it be possible to have trade without information coverage, and also to what extent would it be possible to have war without information?

If there were no coverage of any sort of any war, no reports, no information, how would this change the nature of war? To what extent is war accelerated and raised into a potent force just by good coverage? To what extent is information coverage, itself, aggressive warfare?

In a world in which the whole environment is made of information, it is natural that war should be conducted by the same means and that top weaponry is increasingly that of the image. We call it the "cool" war, and that means totally involving.

I have a friend in New York, Tony Schwartz, the famous tape recording man. He said: "You know, when I came to this part of town, years ago, the police told me: Tony, if you are ever in trouble, never shout HELP. Shout FIRE! They said, if you shout help, you'll get nothing. But if you shout fire, every window will go up."

Now this is the mystery of the "hot and the cool." People don't want to get involved in "help" situations; it is too "cool." Fire is a more reassuring and less involving medium.

There is also one very relevant thing to point out about the computer, which has had its share of attention already. Notice that in line with the school of the rear view mirror, the computer is being set to do all the old jobs, not the new ones. It is like the buggy whip holders in the first motor car. Computers are being given the job of card filing and retrieval. But, the computer, by speeding up the total available human experience, has in effect put outside —as the new environment—the human subconscious or unconscious.

For years I've been noticing the extension of consciousness by various technological means. The human unconscious is the total experience of mankind, stored without any story line, just jumbled and assembled in the human unconscious. Now, with instant dispersal and instant retrieval systems, we have the all at once. We have put outside us, as a new environment, the unconscious which is part of that return to the age of the hunter, the most primitive form of human society.

The Environment as the Product of Consciousness

The unconscious, just because it is an all at once world of everything that ever was, now becomes environmental. We can now have outside ourselves everything that men ever were, or knew, or experienced—simultaneously. This perhaps does relate to the satellite environment of our planet, turning the planet into an old nose cone, an old hunk of camp, an old art form.

The availability of the unconscious also insures the future in terms of investment. I'm pretty safe, I think, in saying that the future of investment on this planet is going to be overwhelmingly the restoration of the planet through all the phases of its development. The countless billions of dollars that will be spent in the next decades refurbishing this planet—just like doing a Williamsburg job on the old planet —will be an overwhelming theme and area, reconstructing the total planetary process as it has come down to us through countless ages. This is the most elaborate form of data processing that is conceivable.

The extension of the unconscious compels man in the electronic age to live, mythically, as a way of pattern recognition, and a way of coping with this vast amount of knowledge. If you look around at the changes in the world of the arts—not to mention science, which is a prolific source of new myths, new mythic form and understanding of nature—you encounter this strange reversal. Way back in the age of the hunter, paleolithic man was firmly convinced that he made his environment. He did it by rituals, dances, and various cosmic communing, and behavioral patterns. Primitive men always thought they made the world; they wound it up and renewed its energies by their rituals.

Instead of just sitting, instead of just being an occupant of the world, we make it. Prior to the Greeks, men thought they made the world; then came a few centuries of sitting and living in the world, man contained in his world.

Then with the age of the circuit, a return to the age of the hunter, man makes his world once more, makes his environment, is no longer just an incidental content item.

Are we not moving very much back into that state?

Is not this conference really dedicated to the theme that man makes his environment, makes his world? Under electronic conditions, we return to that strange state of the most primitive society—*making our cosmos!*

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Dr. Seitz: Our next speaker is Dr. Richard Cooper, Professor of Economics at Yale University.

Professor Cooper: When our hosts asked me to speak, they suggested that I summarize the light which the academic subject of economics might shed on the relationship between technology and international trade, and to quantify if I could the influence of technology on foreign trade and investment. I dutifully read all that I could find by professional economists on this subject, much of it not yet published. On the basis of the material I could find, I must give the profession low marks.

Economic theory has largely skirted the issue, both on the side of technology and on the side of trade. The contribution of technology to economic growth has, up to now, been derived simply as a residual, after allowing for other things which we know about.

The difficulty in quantifying the effect of technology on trade is, however, I think intrinsic, as I will try to indicate.

Quantifying the Effect of Technology on Economic Growth

Robert Solow, ten years ago, estimated that technical change accounted for about two-thirds of the growth of the U.S. economy, after allowing for growth in the labor force and in the capital stock.

Edward Denison in 1962 whittled the contribution of what he called "increased knowledge and its application" down to twenty per cent, after allowing for more efficient use of existing resources and better education of the labor force as well as growth of the labor force and the capital stock.

Lately a more positive approach has been taken to measurement of the contribution of technology, but we still must rely excessively on such imperfect indicators as expenditures for research and development, the number of scientists and engineers engaged in research and development, patents applied for, patents granted, and so on. We still do not know how to measure satisfactorily the productivity, or output of these various inputs. We assume we are getting our money's worth, but we can't measure the value well.

Trade Theory and Reality

The situation is not much more satisfactory on the side of trade. Most theoretical discussions of international trade involve what may be called traditional trade, the exchange of food for raw materials or for simple manufactures. David Ricardo, the English inventor of our theory of comparative advantage to explain trade flows, drew his example in terms of wine and cloth.

The United States imports coffee and exports wheat, both as a result of climatic and soil differences. Europe is often characterized as an importer of food, fuels and other raw materials, and an exporter of manufactures.

The composition and direction of trade depends, in the theory, largely on natural endowment, although occasionally special skills are also involved.

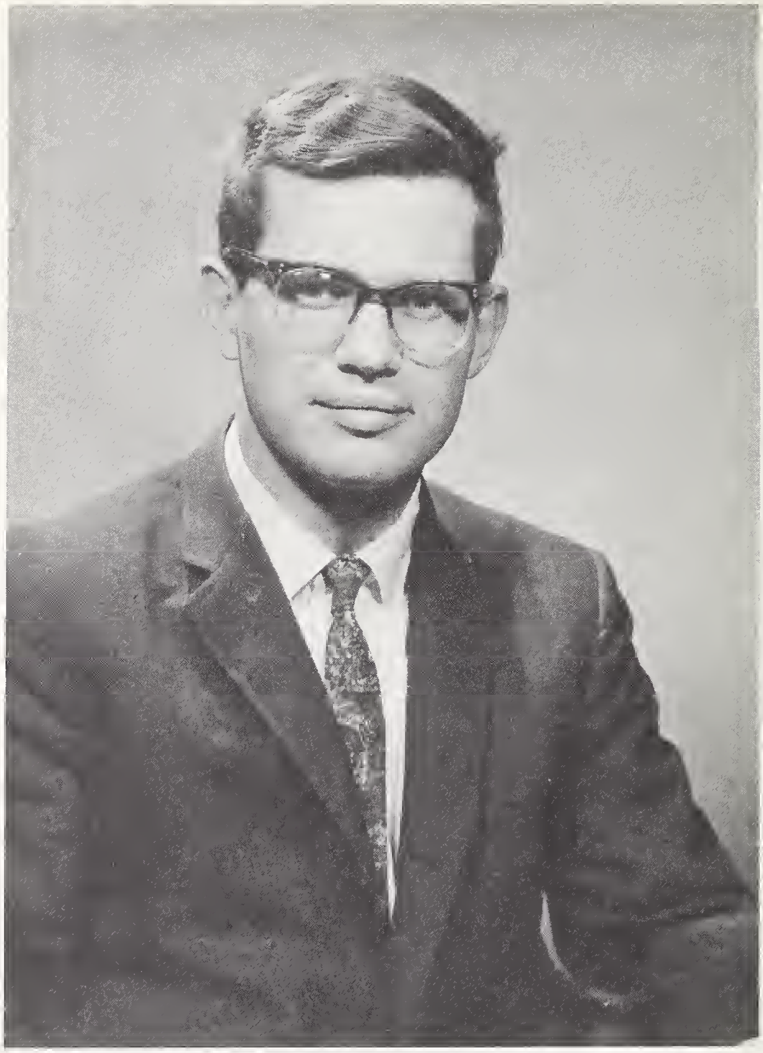
It is difficult to reconcile this theoretical picture of trade patterns to the patterns which have actually developed.

Manufactured products now account for nearly sixty per cent of the value of world trade, up from twenty-five per cent in the 1920's, and the proportion is still growing. Trade among major industrial countries now accounts for nearly half of world trade and the share of this trade which is manufactures has grown even more rapidly than is true for the world as a whole.

The growth in trade of manufactures does not reflect a need to pay more in manufactures for the food and raw materials needed by the industrial countries. It represents increasingly an exchange of manufactures for manufactures. The growth of this type of trade is due to a variety of factors, including the reduction in trade barriers over the last fifteen years, and the rising importance of brand name products in consumer purchases. But a key factor may also have been the rapid pace of technological innovation which has taken place. An innovation adds to the list of export products, at least temporarily, and trade is stimulated.

Quantifying the Effect of Technology on Trade

We have little quantitative information on the influence of technical change on trade. Nearly ten years ago, the Danish economist, Erik Hoffmeyer, studied the pattern of U.S. trade and found that the



RICHARD N. COOPER *is Professor of Economics at Yale University. Earlier, he served for two years as Senior Staff Economist for the Council of Economic Advisers, followed by two years as Assistant Professor of Economics at Yale. He then returned to the U.S. Government on leave from Yale to become Deputy Assistant Secretary of State for International Monetary Affairs prior to assuming his present position.*

A graduate of Oberlin College with his B.A. in 1956, Professor Cooper acquired his degree of Master of Science in Economics in 1958 at the London School for Economics and four years later his Doctorate from Harvard University.

Dr. Cooper's publications have treated the international aspects of technical change and long term trends in trade and economic growth, as well as international financial issues. He has addressed himself extensively to the competitive position of the United States and to problems of national economic policy in an integrated world economy.

United States tended to specialize in what he called research-intensive goods. He found that U.S. exports of these research-intensive goods increased twenty times between the period just before World War I and the mid-fifties, while exports of traditional goods merely trebled.

More recently, several studies have shown that there is a striking relationship between U.S. export performance and several measurements we might think are related to technical change.

Donald Keesing has found, for example, a very high correlation, industry by industry, between research and development expenditures in relation to sales and the U.S. share of exports of manufactures by all the OECD countries. The relationship between U.S. export performance and share of industry employment occupied by scientists and engineers is similarly high. The weight of the evidence leaves little question that there is some relationship, at least for the United States, between export performance and industrial research and development.

This relationship deserves closer scrutiny. First, it should not blind us to the impact of technical change on more traditional forms of trade and, second, we should not take for granted the direction of causality in the relationship just noted.

As to the first point, the impact of technology is clearly not limited to the generation of new products which enter international trade. Our attention is usually focused on these—the visible products, the jet aircraft, the new computer, synthetic fibers, the new drugs. But the influence of technology is far more pervasive than that.

In addition to these product innovations, there are also important process innovations, improvements which lower the cost of producing and moving a wide variety of goods, including goods of the traditional type. Examples of such cost-reducing improvements come to mind in concentrating metal ores, producing steel, weaving cloth, harvesting grain, raising chickens.

Some innovations have a double role. They involve the new product and they lower costs in producing traditional products. The sewing machine and the mechanical reaper are now classic examples; the machinery industry is replete with current examples.

Sometimes the so-called traditional products are themselves improved through advances in technical knowledge. Selective breeding has increased both the yield and the quality of many agricultural products and has produced chickens and turkeys which far surpass their scrawny ancestors in edibility. Purity of refined metals has been increased. New alloys have greatly increased the performance of these metals, and so on through most products.

Furthermore, trade has been greatly encouraged by the impact of technological change on the transportation industry. The big change came in the 19th century with the railroad and the steamship, but these changes have not ceased. Ocean freight rates continue to decline relative to the value of goods shipped and large bulk carriers with specialized port facilities will make profitable the movement of large amounts of low value goods, many being the traditional products.

Air transport will come into range of an increasing number of goods as air cargo methods improve. International air freight rates have fallen twenty per cent in the last decade while other prices were generally rising, and the trend will probably continue downward.

It is worth recalling, however, that not all technological advances stimulate trade. Some of the major developments have the opposite effect, as when nylon largely replaced silk, or when the Haber process permitted fixation of nitrogen from the air and reduced dependence on natural deposits.

Such developments reduce dependence on geography and substitute, as it were, technology for geography and climate, tending to lower imports.

For all these reasons, it is not possible to identify the impact of technology on trade by focusing on a short list of technologically visible goods. The impact is much more general, operating on production costs and transport costs as well as producing new products; and some improvements may inhibit rather than stimulate trade.

In view of this it may be asked, however, why on such measures as we have there is in fact such a close relationship, at least for the United States, between exports of certain goods and technological inputs into those industries. This close relationship has already been noted. I would suggest, however, that it requires an interpretation somewhat different from the one usually cited or implied. This latter interpretation treats R and D expenditures as largely autonomous, determined primarily, say, by government concern for national defense. But much R and D is itself responsive to commercial demands for new products as incomes grow and for new labor-saving techniques of production as wages increase and labor becomes more expensive. Technical improvements tend to respond to the demands primarily of the domestic market. Many of the resulting improvements also stimulate exports, either by creating new products or by lowering the cost of existing ones.

There is some evidence, at least within the electronics industry—I assume the same is true for other industries—that those firms whose research and development programs are geared toward commercial application, rather than government contract work, do much better, both in the home market and in foreign markets, than is true of firms whose research effort is oriented heavily toward special requirements of government contracts. These often involve very exacting requirements which domnate cost considerations. For commercial applications, cost considerations are important.

A Few Countries Are the Primary Technical Innovators

Domestic demand attracts private research, and research success satisfies new market demands, both at home and abroad. It is not surprising in view of the relationship between the domestic market and directed research, that the great majority of the innovations take place in half-a-dozen to a dozen countries, and that among these the United States plays a leading role.

Quite apart from the effect of size—the proportion of Nobel Laureates in the last 15 years who have been American corresponds roughly to the U.S. share in free world industrial production, for instance—there are two reasons for supposing that the United States might generate a disproportionate share of commercial innovations. The U.S. economy is on the frontier of experience, as it were, in two respects: first, per capita incomes are higher in the U.S. than elsewhere and have continued so for a number of years; second, closely related to that, wage rates are substantially higher than elsewhere and are continuing to rise, so that American businessmen face before others the need to find new labor-saving techniques of production.

The first of these effects can be seen in a wide range of consumer products which were first produced on a massive scale in the United States—automobiles, household appliances, telephones, hi-fi sets, small boats, small aircraft. The potential demand for such products not only generates improvements in the products themselves, but also induces improvements in productive techniques to service the volume of demand and to bring the product within the reach of the mass consumer a bit sooner.

High Labor Cost as a Stimulus to Innovation

The second effect can be seen in the long history of U.S. innovations directed at the conservation of labor, which has always been high cost relative to other productive factors and which on some occasions has simply not been available in the quantity or quality required to satisfy domestic demand with old techniques of production.

The sewing machine, the linotype machine, the typewriter, shoe machinery, and down to data sorting machinery and the computer are only the best known of these labor-saving innovations.

Labor-saving innovations were often U.S. inventions. The need drew creative attention to possible solutions. Very often the inventions were made elsewhere but first widely used in the United States where there was a wide receptivity to improvements in techniques.

A typical illustration of the importance of receptivity as distinguished from just the generation of new products is offered by the sewing machine, which in a primitive but effective form was invented by a Frenchmen, Thimonnier, sixteen years before Elias Howe constructed his machine in the United States. It was actually used to mass produce uniforms for the French Army (an earlier example of government support for innovation), but the Parisian tailors formed mobs, smashed the machines, and forced Thimonnier to flee to Paris. The labor-short U.S. economy could not afford the luxury of foregoing an important labor-saving device.

Resistance to technological improvement is not absent today on either side of the Atlantic, but presumably it is not carried to the lengths of the Parisian tailors. So long as labor costs are highest in the United States, however, and are expected to rise further, the incentive to devise new labor saving techniques will be strongest there. As wages rise in Europe and elsewhere around the world, businessmen there will be passing through a range of experience already passed in the United States, and the possibility of borrowing labor-saving techniques rather than having to generate them will be much greater.

On both counts, high per capita incomes and high and growing wage rates, innovation is therefore likely to be somewhat stronger in the United States until incomes elsewhere and labor costs rise to the U.S. level, a day that, at least for Europe, is still some distance off, but is at least within sight.

The choice of technology available to less developed countries will be even wider and it is at present a matter of considerable debate whether they should in general adopt techniques now obsolete in the major industrial nations but which are appropriate to the availability and cost of labor in those countries, or whether they should adopt the latest, most up-to-date techniques even though they are labor labor-saving.

The Stream of Innovations

Technological innovation can undoubtedly strengthen the competitive position of a country in which the innovation takes place, whether it be one which enlarges exports or displaces imports. However, technological advantage in any one product is transitory. Once a break-through has been made, the new information is typically spread widely. Underlying cost considerations will ultimately govern where it will be produced and where it will be used.

For the impact on trade, we must look not to the individual product (because of obsolescence it may not even be marketable long enough for basic cost considerations to come into play) but to the stream of new products and processes, each one often replacing previous ones.

The advantage which accrues to a country's trading position depends both on the intensity of the stream of innovations and on the rate at which new knowledge is put into use elsewhere, where the basic cost advantages lie.

Intensity of the stream is partly accidental, the product of individual and uncoordinated inventive effort, but it is increasingly the product of systematic and coordinated application of talent and resources to discovery.

What we may call the research and development industry, programmed expenditures for the development of new techniques and new products, absorbed in the United States only two-tenths of one percent of GNP in the early 1920's, but has grown to 2.8 percent of GNP in 1960 and must be three percent today. Even excluding government financed research and development, the expenditure grew sharply from the '20's to over 1 percent of GNP for commercially financed R & D today.

Business incentive to develop new products is strong as the public with steadily increasing incomes gets sated with the traditional necessities of life. Other countries have experienced a similarly rapid growth of programmed R & D expenditures over the same period.

Is Spill-Over a Significant Source of Innovation?

Not all of these expenditures contribute to the stream of commercially relevant innovations. Much R & D expenditure, especially in France, Britain, and the United States, is financed by the central government in pursuit of national defense. There is a lively debate about how important is the so-called spill-over from this military research. There are a few examples where military R & D has had clear commercial application, such as the jet engine. In other cases, military R & D has pioneered a field and led to further development work aimed at the civilian market. This was to some extent true of computers which started on government contract.

But students of these spill-overs in the United States find them to be surprisingly small. They are difficult to quantify but it is noteworthy that in the mid-fifties only four percent of all patent applications arose from defense contracts, even though the Defense Department financed roughly half of the total U.S. R & D. Furthermore, commercial utilization of private patents arising from government-financed R & D is only thirteen percent, compared with around sixty percent for patents arising from private development work. One aerospace firm reported that out of four hundred patent applications accumulated by the end of the 1950's, only three had commercial application.

Indeed, there is some concern in this country that very large government R & D programs may actually reduce the stream of commercial innovations by drawing away critical scientific and engineering talent into military and now space work to a greater extent than the pool of such skills is augmented by the attractions of these programs. Fewer men are available for commercial research and development.

Finally, even when there are spill-overs, much commercial R & D is often required to adapt them to the commercial requirements. It has often been firms other than those doing the military work which have made the products commercially successful. As noted above, export success, at least within some industries, seems much more closely related to privately financed research and development expenditures than to total research and development expenditures.

International Diffusion of Technology

The intensity of the stream of innovation is only one factor governing the trade advantage a country gains from technological change. The second important factor is the rate at which new knowledge is diffused abroad. Unless the innovating country enjoys a basic cost advantage in producing the new product, its trade position is enhanced only to the extent that there is a lag in time between its production of the product and new production in other, lower cost locations.

While the evidence we have is only fragmentary, it does not seem as though the international diffusion of new techniques of production or of new products is much more rapid today than it has ever been in the past.

The point is illustrated by the quip of a few years ago which went, "In January, an American invents a new product; in February, Tass announces that a Russian had invented this product thirty years ago; and by March, Japan is exporting the product to the United States."

In times past, great efforts were taken to prevent the diffusion of technological knowledge to preserve monopoly for those with the specialized knowledge. The secret of Tyrian purple was so tightly kept by the Phoenicians that it was lost in the course of time. England, seat of the industrial revolution, was much aware of the advantage it gained by the new machinery and took stringent measures in the 18th and early 19th Century to prevent the export of machinery, especially of textile machinery. The export prohibitions on capital goods were not finally removed until 1843.

France had similar restrictions. Many Germans were worried about the export of capital goods right up to the eve of World War I out of fear that it would undercut their markets.

Knowledge can be transmitted through emigration as well as through the export of capital goods. The first spinning mill in the United States was set up by an Englishman, William Slater, in 1790, who had to memorize the machine design before he emigrated. Britain was very much aware of this possibility and imposed heavy fines on skilled English workmen who went abroad. Those who were abroad for more than six months, despite notification from the British Embassy to return, lost their British citizenship and all their property was confiscated.

This kind of impediment to the movement of knowledge was largely swept away by the free trade sentiment of the 19th Century, and today such restrictions are generally limited to goods of military application. Even without such deliberate impediments to diffusion of technical improvements, diffusion has been slow, but it has been accelerating. The evidence we have is largely anecdotal, but as an illustration consider the typewriter, which was invented in the United States in 1868 and by the mid-eighties had quite a large market in this country. It first appears as a separate entry in U.S. export statistics in 1897 with exports amounting to $1.4 million. A report of 1908, eleven years later, indicates that American typewriting machines had only German competitors in Europe. Actually by that time there were also two British firms with exports of $90,000, a negligible amount compared with U.S. exports of $6½ million. Broadly speaking, it took twenty years from the time of heavy marketing in the U.S. to the time of modest exports by the few leading competitors, Britain and Germany.

Compare this with more recent developments. Within a year of the introduction of stainless steel razor blades by Wilkinson Sword, a British firm, several American firms had competing blades on the market. This was a defensive response and it was rapid. The inauguration of new techniques has only been slightly less spectacular in other areas. Float glass was produced in the United States only four years after the pioneering production began in England. Many computers have been produced in Europe within a relatively few years after they were first marketed in the United States.

Even where international trade is not directly involved, new technology moves quickly. For instance, U.S. firms introduced much more efficient methods for generating electricity from coal in 1949. By 1956, seven years later, all new French generating capacity incorporated the new technology and a substantial part of new British capacity did.

We have other indications of the rapid diffusion of technical knowledge. One is the so-called international patent crisis, where the number of cross-filings has increased to such an extent that most national patent offices are in heavy arrears in their work. A second is the great expansion of patent licensing across national frontiers. The United States alone earned more than $1 billion from foreigners last year in royalties, license fees, and management fees—exports of knowledge, disembodied from exports of goods and even, in many cases, from exports of capital.

Finally, there has been a large and growing amount of direct foreign investment abroad—the creation of the multi-national firm. Such investment tends to diffuse technical knowledge and management skills as well as, or even perhaps more than, capital.

Leads or Lags?

I will close by venturing some speculation on these trends. In the first place, they offer some partial explanation for the baffling conjunction of two arguments, one on the eastern side of the Atlantic, that the so-called technological lead of the United States is increasing, and the other on this side of the Atlantic, and with some vigor only a few years ago, that the U.S. competitive position in world markets is being weakened because of a diminution in technological lead. In fact, both arguments probably represent unwarranted generalizations from particular examples and, of course, both tendencies can be observed simultaneously by looking at different industries.

A more sophisticated reconciliation would refer to the two basic dimensions that I have just been discussing. The intensity of the stream of innovations from the United States may have increased—we still await evidence on whether that is actually so—but at the same time, the rate of diffusion of this knowledge to other countries has also increased. From the viewpoint of competitiveness in international trade, it is the product of these two factors which is important, neither one alone.

Speculating on the Future Basis of Trade

The very rapid diffusion of new technological knowledge along with the great accumulation of capital which is taking place in most countries suggests a deeper irony. It is that most large countries will become more alike over the course of time in their structure of production and levels of income, and they can become economically more self-sufficient. The basis for trade among them will be undercut. There is already some evidence that most Western countries do look more alike in the structure of their production, particularly in manufacturing production, than they did in the past.

Trade has certainly not diminished among these countries, even relative to output, but even while technological change throws up new products for trade, rapid diffusion of this knowledge reduces the underlying basis for trade.

One can even speculate—idly, for most of us—that in the course of time there will be a swingback in relative importance to the traditional trade with which we started out—trade in food and raw materials, whose production costs are rooted in climate and natural endowments—while advances in technology and rapid dissemination of new knowledge permit many countries or small groups of countries to produce their own requirements of the other commodities or services.

Perhaps this is one of those historical reversals to which Professor McLuhan has referred, like the complete cycle from a tailor-made service economy through mass production and back again.

Dr. Seitz: Thank you very much, Professor Cooper. Now, we will begin the discussion period and I would first like to call on two formal discussants. The first is Dr. Hendrik Casimir, Director of the Research Laboratories of the Philips Industries of Holland.

Dr. Casimir: I am not certain that the remarks I am going to make relate directly to what the two speakers have said, but I should like to make a few comments on the role of basic science in technology.

Fundamental science is and should be an aim in itself. It is one of the most noble endeavors of mankind to discover curious facts, to relate the apparently unrelated, to build abstract edifices of theory, to probe the universe as astronomers do, and to probe the smallest particles as the high-energy physicists do.

It creates a beauty, an understanding and harmony. One doesn't perhaps go so far as Heinrich Hertz, who, when working on his thesis, said to his mother: "Poor mother. What a pity that this type of beauty will forever remain a closed book to you." Had I said this to my mother while working on my thesis, she would have said, "Oh, yes, you are a dear little boy, but don't talk such ridiculous nonsense." But then she was a very wise woman. It happens, however, that this basic science provides increasingly the tools without which entrepreneurs and inventors and innovators would be completely helpless and without effect.

The Debt of Technology to Basic Science

I have heard statements that the role of academic research in innovation is slight. It is about the most blatant piece of nonsense it has been my fortune to stumble upon.

Certainly, one might speculate idly whether transistors might have been discovered by people who had not been trained in and had not contributed to wave mechanics or the theory of electrons in solids. It so happened that inventors of transistors were versed in and contributed to the quantum theory of solids.

One might ask whether basic circuits in computers might have been found by people who wanted to build computers. As it happens, they were discovered in the thirties by physicists dealing with the counting of nuclear particles because they were interested in nuclear physics.

One might ask whether there would be nuclear power because people wanted new power sources or whether the urge to have new power would have led to the discovery of the nucleus. Perhaps—only it didn't happen that way, and there were the Curies and Rutherford and Fermi and a few others.

One might ask whether an electronic industry might exist without the previous discovery of electrons by people like Thomson and H. A. Lorentz. Again, it didn't happen.

One might ask even whether induction coils in motor cars might have been made by enterprises which wanted to make motor transport and whether then they would have stumbled on the laws of induction. But the laws of induction had been found by Faraday many decades before that.

Or whether, in an urge to provide better communication, one might have found electromagnetic waves. They weren't found that way. They were found by Hertz who emphasized the beauty of physics and who based his work on the theoretical consideration of Maxwell. I think there is hardly any example of twentieth century innovation which is not indebted in this way to basic scientific thought.

Basic Science Awaits Use by the Entrepreneur

I am quite certain that sooner or later the work that is now going on in high-energy physics, on problems like parity conservation and the eight-fold way and the theory of unitary groups and so on, will in some way or other lead people of enterprising mentality and of inventive skill to come forward with entirely new branches of technology.

These basic aspects of science are common property. They are available to the whole world, for everyone who wants to study them, and by the time they are being used they are usually condensed in excellent textbooks and manuals. You don't have to repeat these studies to be able to reap the harvest, but one must have certain powers of absorption. One may ask whether these can be obtained, can be present to a sufficient degree without some involvement in the scientific field.

HENDRIK BRUGT GERHARD CASIMIR *is Director of Research Laboratories for the N. V. Philips Industries of Holland. Concurrently, he serves as a member of the Advisory Council for Science Policy of the Dutch Ministry of Education and Sciences, The Hague. He is currently in the United States as a member of the Team of Examiners of U.S. Science Policy for the Organization for Economic Cooperation and Development.*

He has been with the Phillips organization since 1942, assuming his present position in 1946 after four years of research in physics. Preceding this, he was for ten years Professor of Natural Science at the University of Leyden.

Dr. Casimir, a native of The Hague (1909), studied theoretical physics at Leyden with Ehrenfest, at Copenhagen with Niels Bohr, and at Zurich with Pauli. He was awarded his Doctoral Degrees in Mathematics and Natural Sciences by the Universities of Leyden and Copenhagen. Dr. Casimir is the author of numerous publications in the fields of theoretical physics, applied mathematics and low temperature physics.

The case of Japan was mentioned. It is true they went into transistors without very large investments in solid state research, but in my view their proficiency in absorbing knowledge is not entirely unrelated to the fact that Japan, after all, produced two Nobel Prize winners in physics and a number of other leaders in research.

It has something to do with the fact that Japan before the World War pioneered in certain magnetic materials. It has to do with the fact that on the roofs of our houses we find television antennas of the Yagi type, invented by Professor Yagi in Japan. He was a man who encouraged Yukawa not to study atoms but nuclei, and so Yukawa was led into the study of nuclear forces. This indirect route made him not only the winner of a Nobel Prize, but also the originator and father of high energy physics. And it has something to do with the fact that, at present, in the Japanese school of theoretical solid state physics, a man like Kubo is dominating parts of the field. Is this mysticism? You will have a hard time to convince me that this is a myth that should be broken. I might conclude with one or two examples from my own country which show that proficiency in certain research may not lead to technological and commercial results, without the sup- port of sufficient enterprise, but that in another wa it still has certain influence in the whole picture.

Let's take three cases of Dutch Nobel Prize winners: Kamerling Onnes, who liquefied helium anc discovered superconductivity. It did not lead to ar immediate development of cryogenic industries ir the Netherlands. It didn't give us—even though th primary logical circuits were also made in Hollan in the thirties—it did not give us a great advanc toward launching a cryogenic computer. Technolog and industry weren't right for that. Yet when ir Holland one decided to tackle certain aspects o cryogenic engineering, the existence of this traditior helped us quite considerably.

The fact that electrocardiography was discoverec in the Netherlands did not lead at once to a grea business in electromedical equipment. Yet the fac that there was a general level of medical researcl contributed to the fact that Holland now exports a lot of x-ray equipment to other countries.

The invention of the phase contrast electron-microscope by Zernike did not lead to a great manufacturing enterprise for such microscopes. Still, it is in my opinion related to the existence of a prosperous optical industry in the Netherlands.

These are the few remarks I wanted to make anc which perhaps can be contributions to the discussions of today and tomorrow.

Dr. Seitz: Our next formal discussant is Dr. John E. Reynolds, who is advisor to the Division of International Finance for the Board of Governors of the Federal Reserve System in Washington, D. C.

Dr. Reynolds: I think it is important that we give the audience a chance; therefore, I will try to be very brief indeed. Perhaps the most useful thing I can do is to note the one or two of the points at which it seems to me the different remarks we have heard this morning bear upon each other.

Seeing Things as a Whole

One of Professor McLuhan's themes is that the new technology, the electronic or the information technology, enables us to see things whole; indeed, it compels us to see things whole. We have to take refuge from information overload in something he calls pattern recognition.

I think throughout all the major speeches of this morning has run the thread of "having to see things whole" in analyzing the role of technology in world trade. I see this in at least three different aspects.

Learning to Use Technology

First, that we have to have a sense of history; that we have to see a time continuum, and recognize that the past is linked with the present and that with the future. Both Secretary Connor and Dr. Seitz reminded us that man has had technology as long as we have any record of his existence. Technology and trade have been the essence, really, of our whole rise from the cave up to our present state of life.

And while, as Professor Cooper says, economists will differ on whether it has contributed one-fifth or three-fifths of our progress—depending on how they allow for education—still that's where economic growth comes from—technology. While we perhaps can't measure it quantitatively, we know that it is so and we recognize the success in the adaptation to and the exploitation of technology to meet human needs.

I think we haven't made a quantum jump into a brand new kind of world with our new technology, but we have a long experience of making use of technology. Our pace may be faster now than before, so that we have to learn to adapt ourselves faster than before or run greater risks of not adapting, but we can still learn from the past. Economists who plot growth rates find that they are faster now than they were—but it is four percent per year instead of three, or perhaps four-and-a-half percent instead of three, rather than some brand new order of rate of change that we are experiencing.

The Characteristics of Trade and Investment

A second way in which it seems to me we need to see things whole—and this, too, was stressed by several of the speakers—is that international trade and investment are really only aspects of or extensions of trade and investment as a whole. Economists may be partly to blame for having made the study of international trade such a very special thing as if an export were quite a different thing from ordinary shipments say from Buffalo, New York, to Atlanta, Georgia. They are very similar things, and while national boundaries are there and matter—matter very much to lawyers, matter very much, too, for certain tax purposes and so on—still the essence of the way in which technology contributes to the quality of life is quite general and can't be viewed as different in its international trade and investment aspects than in domestic trade and investment aspects.

Viewing Economics Globally

Finally, I think Mr. McLuhan has impressed upon us that the world has become really a global-sized village and we can't so readily take partial and private viewpoints of the needs of the world. We have to think, really, of the thing as a whole, now. We are doing that more and more, and one reason we have moved ahead rather successfully in an economic and technologic way during the two decades since World War II is that we have been taking an over-all view. It is true in the field in which I work, international economic policy; and, incidentally, I think that the extent to which we profit by technological advance is importantly conditioned by whether we follow sensible or foolish economic policies.

People talk of competitiveness, but you can't talk of that in technological terms alone; it has to do with prices and exchange rates as well as with physical characteristics of processes. The OECD has been

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Mr. Reynolds studied Economics at Harvard University, receiving his Bachelor's degree in 1944 and his Master's in 1950.

mentioned. It is very encouraging that people go regularly from all over the developed world to meetings in Paris of the OECD to consider together how they may jointly improve their policies towards the development of technology and also their economic policies which bear on the rate at which technology can be usefully applied. The very days of this Symposium are also days for another round of meetings for the OECD Science Policy and Economic Policy Committees.

Professor Cooper mentioned two reasons for the very rapid expansion of world trade in recent years, two among several. One, that trade barriers have been lowered, and, two that the pace of technological innovation has been rapid. These two interact very much. We have had to lower the trade barriers in order to take advantage of the technology and, conversely, by lowering the trade barriers, we have broadened the scope of beneficiaries from technology. I agree with the Secretary, most heartily, that the main task for all of us is to keep things free and remove obstacles, as much as possible.

Can We Learn to Transfer Technology Across the Equator?

There is a tendency to focus on the problems of flow of information and technological gaps mainly across the Atlantic, whereas in my view, the problems are much less serious across the Atlantic than they are across the Equator. I hope at some point during this meeting that people will take a good hard look at the problem of how you transmit technology from highly developed countries to less developed countries. The challenge is that this needs to be done with none of the long experience we have had and needed in building up stable governments with some support from scholastic research experience. Looking back from fifty years from now, the real test of our times will have been not whether we have got along well across the Atlantic, but whether we were able to transmit to the much poorer countries of the Southern Hemisphere the means of making progress.

QUESTIONS FROM THE FLOOR

Dr. Seitz: The session is now open for questions or comments. Does anyone wish to start?

Dr. Melville Green (NBS): I was much stimulated by Professor McLuhan's talk. He has ways of describing patterns by which we can try to understand our current civilization and the one that is rapidly bearing down on us.

However, some of his patterns seem to be somewhat contradictory and I wanted to ask him to clarify. In particular, he was discussing our young people and he said that they are learning by discovering rather than by sitting in a classroom and being taught.

The image is of a more active pursuit of knowledge. This was reinforced by his image of the hunter. However, toward the end of his talk he mentioned that we all seem to be turning into television screens and becoming more oriental and perhaps more passive.

I would like him to comment on what seems to me a contradiction, or perhaps one shouldn't at this stage of the game look for consistency but rather as in modern physics, find complementarity.

Professor McLuhan: Yes, I wished to indicate that the coming pattern in education is moving away from instruction toward discovery, just as in business and other organizations generally, people want more involvement. It doesn't matter what the age group or the operation is. In the same way, children today, in their new electric environment, have come to expect much more involvement in the decision-making and in the learning process.

I don't say we have *done* anything about this. I didn't wish to indicate that anything has been done about this. Nothing has been done. But the children are sitting there waiting to be involved in the process of discovery by being sent out into the society in small teams to do research, to discover and thereby learn.

Professor Oppenheimer used to say, "There are kids playing here on the sidewalk that can solve some of my toughest problems in physics because

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they have modes of perception that I lost forty years ago." The idea that you can use children in high level research is not something we are doing anything about. No. It is just a coming possibility, that's all.

The other matter of TV screens refers, not to passivity, but to the exact opposite. TV is a profoundly involving medium because it takes us inside ourselves actively and inquisitively on a kind of a trip, as it were. LSD and TV are closely related. LSD is merely a physiological analogue to TV, and the craze for LSD is nourished by the TV screen. The TV screen is not the movie screen, it has nothing to do with the old movie camera technique. You see, the movie camera extends the eye and takes you out into the environment. TV does the exact opposite. It takes you inside yourself.

Existentialism, which came along with electric circuitry, began with this interior trip into the darkness of our own being. Kierkegaard and Sartre and such people are all part of the western movement inwards, for the investigation of the new frontier. Paradoxically, the new interior trip is unique and singular, is not mass produced; people go on talking about mass production and mass education without noticing that they each now have the exactly opposite character. For the young people in our world today, movement is toward the unique and the singular and away from the mass produced and the general.

So the points that were raised by your question are typical of just how difficult it is to discuss the matters that are part of our current environment. It is much easier to discuss the old rear view mirror image than it is to tackle what is right under your nose. It is very difficult to discuss the present. I have a friend who says the future of the future is the present. True, but the difficulty is to see the present. Very difficult.

Dr. Seitz: Another question?

Professor Rao: We have heard, at this meeting and others, discussion of the effects of science and technology on international dealing and investments. I would like to suggest that the effect of technology in the last twenty years has hardly been sensed in the developing countries as far as their international trade or even their national income is concerned.

What has been the effect of technology and science on the exports of developing countries? How far has it reduced their external dependence? How far has it reduced the gap between their national income and that of other nations? Japan has had a remarkable experience, but other nations have not. I think it would be very good if some research were to be done on that subject and I hope that this symposium and others to follow will deal with that. Should we not deal also with the more effective utilization of the resources already available in developing countries rather than weakening those needs and demands by displacing those resources by synthetics and technological substitutes, for example?

Dr. Seitz: The question, as I think all of you heard, is about what the effect of the technological developments, since World War II, upon the developing countries, treating Japan as somewhat of an exception. To what extent have these countries been helped or hindered? Moreover, to what extent has the development of such things as synthetic textiles had a deleterious effect in the natural fiber industries of the developing countries?

I wonder if one of the panelists would care to speak to this. Professor Cooper?

Professor Cooper: I agree very much with Dr. Rao that we need careful study of this question. I would not, as a preliminary hypothesis, start out with the view that the impact of science and technology has been nil or close to nil.

It is true that the great growth in trade in products having a high technological content has predominantly been among industrial countries, leaving aside, as he did, the export of capital goods to the less developed countries.

Most of this vast growth of trade has taken place among the industrial countries and the less developed countries have been in a kind of a backwater. Still, one can point to numerous examples where advances in technology have contributed to the foreign exchange earnings, the additional receipts, of less developed countries. Things come to mind like the greatly improved strains of rubber which are now being produced and exported from Malaya, the development of new and lower grade sources of metallic ores which due to improvements in the concentration process and reduction in the cost of bulk transport permit earnings from what only a few years ago was regarded as worthless dirt. Developments in transportation, refrigeration, have stimulated the whole banana industry.

What is striking about the examples that I have given is that they all focus on primary products and not on manufactured products. What has happened is that the growth in exports by the less developed countries has been in products with quite a low technological content. It would be useful to have much more detailed scrutiny of why it is that these tremendous improvements in available technology have been left relatively to one side in the less developed countries and have not affected their manufacturing operations much.

Dr. Seitz: Any other comments? A question over here.

Mr. Charles Vetter (United States Information Agency): As prompted by Mr. Reynolds' discussion, I'd like to hear a comment on barriers to the movement of knowledge across the Equator. Are these barriers attitudinal, motivational, conceptual?

We see the same barriers domestically in the urban problems that we have. There seems also to be a parallel between the problems between cultures within our own country, like Appalachia or the urban slum area, and the problems of international movement of trade and technology.

I would like very much to hear Mr. McLuhan's comments on means for influencing the attitudes that are the barriers and perhaps on how technology can be more effective in our training systems for people who are promoting the movements of ideas.

Dr. McLuhan: Well, sir, that's a big order. It has been the traditional function of the arts to train our perception. The artist is the only person who can look at the present, at new environments without fear, and can report what he sees by new patterns and new styles.

The artist has training in perception rather than a blood bank or store of values. Pop art today, for example, is attempting to tell us what our environment itself is—the environment itself has become an art form.

But the training of perception in regard to new technologies and their effects has never been undertaken, except indirectly by the artist. Someone said once, "We don't know who discovered water but we are pretty sure it wasn't a fish!" We are all in this position, being surrounded by some environment or element that blinds us totally; the message of the fish theme is a very important one, and just how to get through to people that way is quite a problem.

We have from the moment of birth a fear of the new environment. We always prefer the old one. We learn by going from the familiar to the unfamiliar. In practice, this means whenever we account for the unfamiliar, we translate it instantly into something we already know. In other words, we refuse to look at the unfamiliar. Our built-in mechanisms of cognition seem to make it impossible for us to recognize the new until we have translated it into the old.

Now there is a technique for discovering the new in spite of our built-in pattern map, and that is by inventory. If you make an inventory of all the effects of the telephone or radio on a society, you will discover a pattern. You have seen the transistor radios teaching children to make their own space bubbles for privacy. Our kids don't listen to radios; they use them as space bubbles for privacy. This has never been studied, but the radio, the use of radio as space in the space age is the type of thing that is having tremendous effect on the lives of the young. You can study these effects by inventory, what effect it has on clothing, on cars, on schooling and so on. It is very difficult to study them by any single concept or point of view.

These inventories yield awareness of new forms that you couldn't get by any other means. This is also where the young can enter the field of research. The young are very good at making inventories of their surroundings; they can become hunters by roaming the evironment, and at the same time getting smart.

Dr. Seitz: I think we have another question here.

Dr. Melville Green (NBS): Professor McLuhan brought before this conference the idea of myths—myths as a spring of action.

Dr. Seitz and Dr. Casimir later on referred to myth in the relationship of classical technology to science. We heard about the myths of technology in developing countries. Myths seem more useful than we may wish to admit. Perhaps what is necessary is a truer understanding of the positive role of myths.

Dr. McLuhan: The word myth is the Greek word for work. Mythos is a work, and is considered a breakthrough. Mythos has a way of explaining some event. The myth is a way of explaining a complex process in a few phrases. As a technique of explanation of cause and effect, it is coming back into much use. Many of the things we call natural laws or ways of describing events are in the old Greek sense of the word, myths.

There is a phrase, "Every breakdown is a breakthrough." This is a mythic form of awareness. Every breakdown is a breakthrough, whether it is in private life or in a corporate organization. Whenever you break down, you have just encountered a very rich untapped potential which creates a new form.

Dr. Seitz: Near the rear?

Comment: It seems to me the discussion this morning points up a fact which is overlooked in the application of technology in international trade. Because we are working in a computer age with things happening at electronic speed, we expect everything to happen both nationally and internationally at computer speed.

It is evident to many of us that in the applications of science and technology in industry that, some twenty years after the end of World War II, we are just beginning to apply many of the outgrowths of military research.

Dr. Casimir has beautifully pointed out that the application of fundamental research has taken anywhere from ten to seventy years before it found utility in engineering practice or application.

We are very impatient to expect that the rapidly developing technology is going to be exported and accepted to produce great forward strides in undeveloped countries immediately.

We have to recognize that in these affairs there is a time lag, that the precursor conditions of education, of acceptance of technical ideas and the ability to use them, have got to come first. When they do, then the applications of technology based on fundamental research in the more technologically advanced countries will find a fertile ground. There will be seeds that will be planted, will grow, and will increase the potentials of the undeveloped countries to have international trade in technological commodities.

Mr. Reynolds: I would like to add just one thing to that. I think too that the international diffusion of technology depends very much on the ability of the relevant people in each country to be able to recognize breakthroughs when they occur, and to adapt them to local requirements. This requires a substantial base of technologically alert people.

One can draw a distinction here, between those who are actually generating new ideas, new products or new processes and those who are very quick at recognizing the useful developments of others. The second is very necessary.

One of the developments which has taken place is the tremendous growth of study abroad, especially in science and engineering and some of the social sciences. Students converge from all around the world on American and Western European universities, and this will in the course of time create this body of people who can receive and identify, recognize and adapt innovations that take place elsewhere.

One of the disturbing results that we have recently observed is that the rate of return of many people from less developed countries from Western Europe and North America to their homeland, is in some cases strikingly low. This process of education abroad at least to some extent robs these countries of some of their best talent. But there is some return. It varies a lot from country to country and I think we should work toward getting it up.

Dr. Seitz: Thank you. This morning's session is now ended and we shall adjourn for lunch.

Luncheon Program

Introduction: Mr. Herman Pollack
Director of International Scientific and Technological Affairs, Department of State

Mr. Pollack: Mr. Secretary and distinguished guests.

The prospects and problems associated with the development of technological capability and the movement of technology among nations are now the object of serious attention in many countries throughout the world. I am sure, therefore, that the discussion under way here at this great and venturesome symposium will be followed with great interest by an international audience of governmental, industrial and business leaders.

The need for a better understanding of and more factual data on these subjects is abundantly clear. This symposium and others that will undoubtedly follow will do much to illuminate and clarify this most complicated topic. I think you will agree that we have witnessed a splendid beginning today to what I am convinced will be recalled in subsequent years as a landmark meeting.

The locale for such a meeting could not be more appropriate. From its beginnings at the turn of the century, the Bureau of Standards has recognized the need for international understandings and agreements in the area of technology and standards. The Bureau has been a pioneer in projecting the United States into international scientific and technical cooperation, and I think these new laboratories are ample evidence that the Bureau does not intend to rest on its laurels.

Along the way, the Bureau has made many friends in many lands, and those here today have come from many lands. Among them is our speaker at this luncheon, Mr. Pierre Uri. He is both a philosopher and an economist, and I think perhaps the combination and the marriage of these two disciplines provides insights very useful to the subject that we are here to consider.

It is an honor and a great personal pleasure to introduce to you one of France's most brilliant citizens and a man who I am sure will be identified with the future development of European unity, Mr. Pierre Uri, Counselor for Studies of the Atlantic Institute.

HERMAN POLLACK *is Director of International Scientific and Technological Affairs for the U.S. Department of State. During his 25 year career in the Federal Government, he first served in a variety of assignments in the Office of Price Administration. Following a period in the U.S. Army, he was with the War Shipping Administration and the Foreign Economic Administration. He began his service with the Department of State in 1946, holding positions as Deputy and Acting Executive Director, Bureau of European Affairs; Executive Assistant, Office of the Assistant Secretary for Administration; Director of the Management Staff; and Deputy Assistant Secretary of Personnel.*

A native of New York City (1919), Mr. Pollack is a graduate of the City College of New York, and holds a Master's Degree from George Washington University.

PIERRE URI *has made many important contributions to French economic policy and to the creation of the European Economic Community. As Economic and Financial Adviser to the French Planning Commission under Jean Monnet, he set up the first French economic budget in 1947. He was active in the conception and negotiation of the Schuman Plan and had an important role in launching the Coal and Steel Community. He then made the plans for the Common Market by preparing and writing the Brussels or Spaak Report, which served as a basis for the Rome Treaties.*

He was a member of the committee which in 1948 produced the report on National and International Measures for Full Employment, and in 1957 he was consultant to ECLA on a Common Market for Latin America. He has, as well, served as a member of two ad hoc committees of the Alliance for Progress.

He chaired the group which produced the 1958 Report on the Economic Situation of the European Community, and then was Chairman of the group of experts which studied long term development prospects in the Common Market. Among his books, one may cite Partnership for Progress (Dialogue des Continents), A Monetary Policy for Latin America, *and just published,* That We May Govern (Pour Gouverner).

At present he is Counselor for Studies of the Atlantic Institute in Paris.

Speaker: Mr. Pierre Uri
Counselor for Studies, Atlantic Institute, Paris, France

Address: **International Competition and Cooperation in Technology**

Mr. Uri: Thank you, Mr. Pollack.

We have been told this morning that we are in a world of accelerating technical progress, that we are witnessing some new patterns of trade. The question to which we have to address ourselves now is how far this change in environment should lead to certain changes in our traditional views of policies. We might only be in need of some adjustments in traditional economic theory, because the old pattern of competitive advantage seems now to yield to the very fact that there are now people with advanced production of something which the others can't produce, and that's the most absolute advantage which you can think of.

This doesn't necessarily make for one-way trade because, as has been pointed out, this technology can be learned, and can lead to a reverse trade when it has been learned by people who have lower wages. In other words, the way trade is now working is by innovation, then imitation, and finally the reverse trade.

Now, we know that this is not new. We have been told of the technological advance of Phoenicia and of China in the old days, but probably it is now a bit broader than it use to be, and people begin to be a bit jealous of the ones who have an advance on this. Let us be quite clear. It doesn't take technical advance to balance one's accounts and the United States is the witness to that. But it means simply you can balance your external account with a higher standard of living.

The Technological Gap and Its Influence on Trade

If, as some people maintain, there is a technological gap, let's not complain about it. If it did not exist, the worries of our host, Secretary of Commerce Connor, about the balance of payments might be even worse. The real question now before us is whether this inequality, if any, is going to be increased or whether there are appropriate policies so that the whole world may benefit.

Measures of Influence of Technology on Trade

One point is immediately clear. It is very often maintained that the balance of sales and purchases of licenses might be a good indicator. I submit that any country, except the largest one, is bound to have a deficit on this. What is the probability that a small country could invent by itself as much as the rest of the world? And there is another way not to have a deficit, and that is not to buy any license. On this basis, the fact that some of our countries have deficits on licenses is just a sign that they are interested in technical progress and this is all for the good.

But there is another feature which I think is interesting to mention. Usually when speaking about conditions of international competition, it is mostly relative magnitudes which matter. In other words, in relation to the cost of a product, how scarce is capital and how scarce is labor?

And maybe with the great knowledge resulting from research, particularly applied research, the absolute magnitudes matter. In other words, if you have to produce something which is completely new, there is a threshold below which you won't be able to achieve anything, and I think that this is the really new feature which the advance of technology brings into the field of international trade.

Technological "Fallout"

Now there is another idea which I think is current but of which we haven't yet drawn all the possible consequences. We all admit that there is so-called technological fallout, meaning by that that the research conducted in one sector spreads to others because a lot has to be learned, and orders have to be placed, and so forth, thus there is a certain cumulative effect from research and development. To some extent, and within reasonable limits, doing the job oneself has more profound effect than purely importing the recipes.

In other words, in a world of that kind, we can no more think purely of competitive advantage, and we have got to think ahead to potential capabilities of developing one day something for which one hasn't yet the start, and to the cumulative effect which may accrue. This is a rather important element which I think reflects even on present international negotiations. I have read somewhere, and I wouldn't disagree, that the famous eighty percent clause of the Trade Expansion Act was a very clever American idea, because, mind you, the products on which most of the world's exports are concentrated in the North Atlantic area are really science-based products.

But the question is whether there wouldn't be a certain case at the beginning for the countries which are less advanced to use the infant industry argument and have some temporary protection, so that they can reap the benefits of things which they will do by themselves.

Foreign Investment Policy

But the reverse side of this possibility should be a completely open policy on their part on foreign investment, because you are not going to have it both ways. If you want to protect yourself for a certain time against imported products because otherwise you might never be able to develop them, then you cannot protect yourself at the same time against the firm which brings the technology with it, giving you the possibility of fully using the new techniques and filling the market.

And I am happy to say that the problem of international investment, which seemed to be a rather hot issue when the Atlantic Institute undertook a study of it, is now slowly cooling off. Even the government of my country seems to have been convinced by the arguments presented by people who don't belong to the majority. And the points which are now being made are very reasonable ones, that the subsidiary of a foreign company must be free to export as is the interest of the host country; that there must be no discrimination in the high level jobs between the nationals of the country of origin and nationals of the host country; and finally, and this is probably the easiest thing to say but the most difficult thing to conceive, that the host country should be fully associated with research. I venture to submit that if this symposium could try and devise some of the criteria according to which some of the research could be done in the host country, that would serve a terribly useful purpose.

But, obviously, the real answer to our problem lies in what the countries which feel that they are less advanced do to restore the balance.

Advanced Technology and Economic Progress

On this, there is one remark which I haven't heard often enough: there is no direct correlation between the efforts on advanced technology and the overall rate of economic progress. In other words, it is not enough to do everything to make up for the lag by concentrating on advanced technology. There must be a balance. It depends, of course, on the orientation of the research, and it is a moot problem how far military technology has civilian spillover. There is also the risk that by investing in a certain direction, you practically dis-invest in others.

And I am afraid that there are some European countries which have made very courageous efforts and have been frustrated, because what it takes is also the management to exploit research and the size of the market to develop it, which means practically that in the European countries that are complaining, the remedy is in their hands.

Cooperative Efforts

It is the basis on which technological cooperation can be organized to be a match to the United States. Now, there are plenty of attempts at cooperation and I have read that there are even now at international or regional levels about three hundred international organizations; I'm sure you could not recite the list.

But it is not enough to say that things are done jointly. The important thing is how are they done. Is it going to be done on a case-by-case basis, negotiated, revised, finally in some cases abandoned? This doesn't create the new environment. Is it going to be done by allocating to one industry this, and to another industry that, so that practically everybody gets back the money which he just put in the pot? This doesn't create either the conditions for real progress. If Europe is to do something and if the notion evoked by the British of the technological community means anything, it should be the agreed principle that any new development, any new industry, any new product is not started on a national, but on a common basis.

Of course, there is one difficulty which we can't overlook, which is that, according to products, not necessarily the same countries are interested or can contribute. In other words, what it might mean—and I venture it as a firm proposal—would be an agreed option of a right of first refusal for those interested countries to join in a product if they can contribute something, and this should be done on as broad a basis as possible.

Up to now, let's be frank, most international cooperation in technological ventures has occurred in a spirit of competition. Two countries come together to beat a third one. We could quote an infinite number of those attempts. I'm sure everybody recognizes that this is not the soundest possible economics.

Commonalities and Equalities

Let's begin to conceive of real international projects. I'm sure there will come a day when we will really wonder that a race to the moon or the exploration of the deep earth could be considered as something other than a project for the whole of mankind because, after all, this is our common earth and this is our common universe. On this common earth, there is one fact which we have got now to face. It is the fact that whereas in our own society we are all trying to have more equality of a basic sort and more equality of opportunity, we are on the contrary faced with the risk of growing inequality between nations, in power, in standard of life, and maybe even in the development of culture.

Well, civilization might be defined as the refusal of natural inequality of the more brutal sort, and what we have done in our society is to refuse brute force so that other values may emerge. This is now the challenge before us.

How have we been able to establish more equality? First, by the rule of law, secondly by the grouping of the weaker. And we are now coming to the idea of solidarity to assure at least a minimum to the underprivileged.

We now have to go over from our own national societies to the international one with the same principles and the same efforts.

Technology and Destruction

One point has been omitted up to now, and I agree that it didn't belong in the title of this conference or as part of the agenda. It is the terrifying contribution that technology can also make to the power of destruction. Against that background, if we accept the philosophy which equates civilization to research for growing equality, an equality which is no more a word but which we begin in fact to have the means to achieve, we may very well save ourselves, to reiterate Secretary Connor's final words, by thinking in terms of mankind.

November 16, 1966

Afternoon Session—The Impact of International Measurement Conventions, Norms, and Standards on World Trade

Mr. Stern: Ladies and gentlemen. This afternoon's session is one that is critical to the principal role of our National Bureau of Standards. It is equally critical to other bureaus of standards around the world; many of them are represented here. Our chairman, this afternoon, is a man who not only speaks the language of standards, fluently and without accent, but is also one who is continually contributing to the vocabulary of the standards world.

It is a great pleasure to introduce the fifth director of the National Bureau of Standards, also the person who planned and executed this project, the creation of these new laboratories which now stand as the culmination of his efforts during 14 years as Director of NBS: Dr. Allen V. Astin.

Dr. Astin: Thank you very much, Mr. Stern. Distinguished guests, our topic this afternoon is The Impact of International Measurement Conventions, Norms, and Standards upon World Trade. Our speakers and other experts from several countries will express their views on this subject.

Personally, I believe that standards underlie all types of communication and exchange. The common dictionary type of definition for standards is "that which is accepted for current use through authority, custom, or general consent." In this context language, of course, is the oldest standard we have, and the most fundamental standard for all communication.

More sophisticated types of communication also require standards. Telegraph systems, radio systems, television systems, and even the automatic data processing systems that were talked about earlier today, are all reaching the stage where adequate standards are a critical factor in their more efficient and effective utilization.

Standards in Science

Among scientists and engineers, communication or exchange of quantitative information depends upon the availability of generally accepted units to which the measurements can be referred: the standard is merely a physical embodiment of one of the units of physical science or engineering. Fortunately, we have, through efforts beginning at the time of the French Revolution and culminating in the Treaty of the Meter in 1875, an effective international system of units in which we can express the quantitative language of science on a compatible, understandable, coherent basis.

Nearly all technologically sophisticated nations of the world belong to this convention of the Meter. The standards carried out under this Treaty support the traditional types of commerce and trade, where it is necessary to have units and standards to which quantity can be referred.

Standards in Trade

The association of standards with trade is expressed, quite significantly, in the United States Constitution, which links together in one phrase both halves of the normal commercial or exchange process. In our Constitution, the Congress is given authority "to coin money, regulate the value thereof, and fix the standard for weights and measures." It is in that context of the *utilization of standards in trade* that we will be concerned this afternoon.

Modern technology has brought into the market place a wide variety of very sophisticated products whose characteristics can only be specified through extensive types of measurement systems. It is helpful in the buying and selling and production of such products to have standards for the performance or the evaluation of such products. These types of standards and their impact on international trade will constitute the major part of our discussion.

ALLEN V. ASTIN *was born in Salt Lake City, Utah, in 1904. He received his bachelor's degree in physics from the University of Utah in 1925 and his Ph.D. from New York University in 1928. From 1928 to 1930 he was a National Research Council Fellow at Johns Hopkins University.*

Dr. Astin joined the staff of the National Bureau of Standards in 1932. His principal fields of work included precision electrical measurements, the development of early radio telemetering techniques, and during World War II the development of proximity fuzes. He was named Chief of the Bureau's Ordnance Development Division in 1948. The President appointed him as the fifth Director of the National Bureau of Standards May 31, 1952.

He serves as the U.S. member on the International Committee of Weights and Measures and as Chairman of the Standing Committee of the Federal Council for Science and Technology.

Dr. Astin: Our first speaker this afternoon is Mr. Francis K. McCune, who is Vice President of the General Electric Company.

Mr. McCune: Dr. Astin and ladies and gentlemen. Let me begin with a little philosophy. It is hard to tell, of course, where standards started. It is fairly clear that monkeys and even the higher primates don't need standards. Even at a still higher level, there was little need for standards when each family produced its own food, its own clothing, its shelter and was self sufficient unto itself. But beyond these stages, standards are absolutely necessary, and this has been recognized since prehistoric times. With civilization comes exchange of goods and services, barter or trade—and standards.

Let me point out here that I am not really talking only about standards like those of time, dimension, weight, money, and so forth. Fundamental as these are, standards go far beyond these essentials. Standards as we know them today usually cover the following:

definitions, so that buyers and sellers speak a common language;

mechanical or electrical specifications, so that components may be freely interchanged;

safety requirements, so that society's interest may not be compromised by transactions between individuals; composition, properties, and methods of test standards for materials, for processes and for devices;

minimum performance specifications, so that the user may know in simple terms what the product will do. Minimum because enlightened buyers are looking for increased values through performance above standard.

If you will permit me one more observation, while standards usually involve compromise, as does the art of politics, they are in toto, I believe, the best index, the most coherent summary of technical knowledge in existence today.

These, then—definition, interchangeability, safety, properties, and methods of test, and performance levels, are basic to trade—and without trade, civilization as we know it is impossible.

The World Trade Picture

So let us look at some figures on trade itself. Total world trade has been rising steadily since the end of World War II, and has doubled during the last 10 years to an estimated total of $200 billion in 1966. Most of the growth in trade has been among the countries that are well developed industrially. The total of world trade appears to be growing exponentially.

There is substantial trade between developed and undeveloped or under-developed countries, or among under-developed countries. I believe, and I believe all of you believe, that trade in these areas is going to increase greatly. Hence, I think we are going to see an acceleration of this rather exponential advance in world trade.

But I think that there are other things that we must look at. I think that growth in technology will also stimulate more trade. The amount of the growth from this cause will depend to a great extent on a number of countries and people that are able to make use of the products which the new technology provides; but I hope and believe that international trade will grow from this factor much faster than in the past.

There are many factors that affect international trade, including tariffs and a variety of other barriers, as has been mentioned this morning, to the free exchange of goods among nations. The main purpose of the several common market schemes around the world is to eliminate these trade barriers where it is feasible to do so.

Importance of International Standards

Lack of standards and differences in standards have long been very troublesome barriers. Fortunately, most countries now recognize that the development and use of international standards will go a long way towards the removal of such barriers. This growing interest in international standards is apparent in the expanding work of the ISO and the IEC. There is no question but that international standards will more and more become the commercial documents by which future international trade will be conducted. We are already seeing evidence of this:

The OECD recommendations on development and use of international standards in its 1964 progress report.

The EEC and EFTA arrangements to harmonize their standards.

CEE and its effort to have common electrical safety standards throughout most of Europe.

FRANCIS K. McCUNE *is Vice President of General Electric Company. In this position, he is responsible for a program designed to assist operating management in the making of major business decisions. Mr. McCune has been with the General Electric Company since graduation, holding many and varied assignments in engineering and general management. He has been responsible for GE's participation in atomic energy programs, including operation of major government-owned installations, establishment of the Company's own nuclear facilities and development of its business in that field. He was elected a company Vice President in 1954, and in 1960 became Vice President-Engineering and a member of the Company's Executive Office. He assumed his present position in 1965.*

A native of Santa Barbara, California (1906), Mr. McCune received his Bachelor of Science Degree (cum laude) in 1928 from the College of Electrical and Mechanical Engineering of the University of California at Berkeley.

Mr. McCune was Chairman of the National Society of Professional Engineers' President's Council of Industry Engineering Executives, is a member of the National Academy of Engineering and is the new President of the United States of America Standards Institute.

Use of international standards by NATO and other treaty organizations.

Use of international standards by the developing countries.

The slope of those curves we looked at a moment ago shows that all our people must engage in world trade or sink to the position of small and insulated markets.

Standards and Developing Areas of Technology

But beyond trade in being, let us look at some rapidly expanding areas of engineering development which will have, or are beginning to have, a major effect on trade.

Man above all animals communicates, learns and records. To communicate, he travels purposefully, and in this century man has increased his speed of travel at least tenfold on land and fortyfold on water. Can you imagine automobiles in widespread use without standards? Standards for materials, for dimensions, for performance measurement, for interchangeability, for the tools used in their manufacture, even for the plants in which they are built. The Society of Automotive Engineers alone has issued well over 2,000 standards.

Can you imagine airplanes without standards?

I am told that even a revolutionary new concept in airplane design uses many thousands of standards. If it did not; the plane could hardly be produced at all. The Aerospace Industry Association in this country has issued over 2,000 standards, and yet both automobile and aircraft freely use ASTM's over 3,000 standards, as well as electrical standards, mechanical standards, government standards and many others.

Let me remind you that a single standard covers a multiplicity of things. For example, typical of the Institute of Electrical and Electronic Engineers, 275 standards are—these are just at random:

A guide for operation and maintenance of turbine generators, which covers 5 methods of temperature measurement, 4 standards on loading, 24 requirements on machine operation, 25 inspection and maintenance procedures on 7 different types of turbine generators.

Transmission performance of telephone sets, which contains 15 standards for test equipment, and 10 test procedures covering 30 different types of tests.

Industrial control apparatus, which covers 17 groups of products with 4 different types of control equipment, with 7 general standards on equipment, with 5 types of interruption, with 11 types of capacitors, 5 classes of resistors, and 12 types of enclosures, for a total of more than 200 standards for individual devices.

In addition, there are individual standards on another 112 devices, so I could go on but I won't.

Man's power to communicate brings us also to the telephone, the radio and television. These are media of mass communication and prime examples of standardization; and again the materials used, the components, the major processes, the means of specifying and describing them all involve standards, as well as the standards truly pertinent to television as such.

Man's ability to record has been primarily by memory and by writing, and these involve language. Language itself is not considered a standard, but is it not really as close to a standard as one can come? Certainly it involves definitions and rules for interchangeability, and now we have machine languages which may in the end have even greater impact. Suffice it to say that machines which talk to each other and to objects in outer space know no pride of nationality, and their language must be standardized.

So we see that man's peculiar abilities have in the past century been enhanced manyfold by concepts, systems and devices which involve standards and which in many ways are dependent on standards.

But let us shift a moment, however, and look at progress, past and maybe future, from a viewpoint of science and engineering. The scientist examines the processes and forces of nature with the hope that he can understand them and hence can usefully predict beyond the limited range of his ability to observe and record. Usually he resorts to measurement to gain his knowledge, and standards are the very essence of measurement. Without them the scientist would be at a loss to conduct his experiments, and even more to communicate them to anyone.

The engineer seeks to use knowledge of nature's behavior to produce things useful to society. Let us look here at the recent past and conjecture a little concerning the future in this field. Each one of us as an individual views progress through a different screen, and we classify it in different ways. So let me talk about the exciting technical achievements of the past forty years as I personally have seen them.

Recent Technological Developments

As I left college, the exciting fields to me were large machines, and in particular the problem of accurate theoretical prediction of performance, which was necessary for a sound design basis as the sizes began to get big; telephone communication theory and practice; tall buildings; high voltage, high frequency and high-current phenomena; deep well exploration of our oil fields. At the same time, as I can remember when I left college, farther out were the development of radio, including high power tranmitters, sensitive receivers, high gain antennas, high-frequency techniques; direct-current power transmission; diesel engines, and in particular the problem of smooth, specifically timed injection which was critical to efficient performance.

These continued to cast their spell, I think, until late in the '30's, when radio and electronics began to come into their own. Television was in its very embryonic stage. There were no common agreements on systems to be studied. Mechanical scanners were still competing with crude cathode ray scanners and image tubes. Control was moving from its primitive state. Systems engineering was being recognized, and with it the ability to engineer units too complex for the single human mind to comprehend.

To many of us then came war and with it concentration on such technical fields as aircraft, aircraft propulsion, control using the speed and versatility of electronics for many purposes. Also, the development of feedback theory and its application to all sorts of automatic controls, such as fast acting generators, voltage regulators, steel and paper mill equipment, and gun-pointing; fully automatic tracking radar; great advances in communication and the use of electronics for recognition and ranging; microwave radio technology—in essence, the marriage of radio and optical theories; infrared technology applied to the problem of seeing in the dark; increased development of analog, and finally digital computers, and so forth. And with these came nuclear energy devices.

Postwar we saw television for the general public, which would have been totally impractical without brilliant and painstaking standardization work; fantastic increases in speed, size, and range of aircraft; application of sophisticated controls to industry generally; rocket engines, not completely new but an accepted engineering challenge of that time because of wartime needs and new technology capabilities; the further development of electronic and analog computers; a whole realm of semiconductors and circuitry, including transistors; the work of making nuclear energy useful to peaceful society; and, only a few short years ago, the beginning of our conquest of space.

Of these, three great waves seem to me to stand out—electronics, nuclear energy, and space. Today we do not know what the next such wave will be but many believe it is here already and it is the information revolution.

The United States of America Standards Institute

Let me pause to remark that for these reasons as well as many others, the new United States of America Standards Institute has come into being. The American Standards Association had a long and distinguished history in inspiring and certifying national standards. The new United States of America Standards Institute will build on this foundation. It retains the principles of voluntary standards, with participation of all the affected segments of society and arrival at a consensus, but is planned to go beyond the American Standards Association in its membership. It is reaching into truly affected sectors of society in its ability to participate in international work. That ends my commercial for USASI.

Future Developments in Technology

Returning to my theme of engineering, what do we see for the next 10 or 20 years or even sooner? Well, this business of predicting is a bad one. I had a boss once who told me what to do on a podium. He said that if you ever have an experiment to perform, first perform the experiment and then tell the audience what they saw. Any other course is disaster. Well, there is a lot of truth in this, and I can remember very well that some years ago utilities in our country asked my company and another to prepare a movie which would be of interest to high school children and might give them some incentive to consider science and engineering as a career. They asked for it to be not just held down to facts but quite far looking, and we put some rather absurd things into this after a lot of thought, far out; a substantial part of this movie was man landing on the moon in the year 2000. That's the fact.

Well, returning to my theme of engineering, what do we see for the next 10 or 20 years or even sooner? Supersonic transports, of course; communication by satellite as the rule worldwide, not the exception; exploration of the moon and space by instruments and by man; the use of space capability for the betterment of mankind, including navigation, air and sea traffic control, economics and dependable point-to-point communication; mass communication, especially for educational purposes, for use in under-developed countries; longer range weather prediction by means of space data gathering capability and advanced electronic computer modeling of global circulation; assessment and control of agriculture, water resources, mineral resources, wildlife and forests, through space observations over a wide range of frequencies and using many kinds of sensors; unlimited resources of economical power; some say the electronic home, with the library, the paper, the store, the business system, where the individual needs in the way of information or communication are at his fingertips in his home.

Some say that we are in a materials revolution, no longer dependent largely on nature, to be able to create exactly what we need for our structures, our machines, and our systems.

Some say the wave of solid state devices is in itself a revolution.

We look to understanding and beneficial control of climate in the less favored parts of the world, the arid and arctic regions; understanding of the influence of the sun on the earth as it affects weather, magnetic storms, communications, and so forth; understanding of the earth's interior and crust, primarily for the prediction in time to give people protection from disasters, such as volcanoes, earthquakes, and tidal waves; cities without traffic jams or bankrupt commuter railroads and subways; and related to this are clean air, clean water, and no unsightly dumps, no junk yards to beautify; hospitals and schools in which the nurses, doctors and teachers would be freed of drudgery and have time for the human aspects of their jobs; unlimited food for the hungry people of the world from a better understanding and integration of marine biological resources, biological fermentation of cellulose or similar processes; understanding, occupation and use of the world that lies beneath our oceans.

These are the things that fascinate our college students today. Yet through all these run two common themes. They are wanted worldwide and they are wanted soon.

Let me submit that if the fruits of the foregoing are to be available as well as wanted worldwide, much needs to be accelerated in our worldwide standards work, for each major achievement requires standards, sometimes for the acceptable cost made possible by a worldwide market and often even to be useful at all.

To come soon, they must be accomplished by the fewest people. Each must not be engineered from the ground up. Each must build to the fullest extent on the compendium of knowledge and accomplishment embodied in worldwide standards.

My conclusion is that we have lots of work to do.

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Dr. Astin: I think it might be better if we hear the second speaker and then ask for questions on both papers. Following that, we will take a brief recess and then call for formal comments by four discussants who are prepared to do this.

Our next speaker is Arthur Henry Ashford Wynn, who is the head of the Standards Division in the Ministry of Technology of the United Kingdom.

Mr. Wynn will talk to us on the subject, "Technological Barriers to World Trade."

Mr.Wynn: Dr. Astin, ladies and gentlemen: The decision to hold a symposium on technology and world trade to mark the dedication of the new laboratories of NBS raises the expectations of all countries. This great enterprise, together with the establishment of the U.S.A. Standards Institute mark, we believe, a change to a higher energy level in American standards activity with which I and the other people from abroad are honored to be associated.

Since last year we have also been awaiting overseas with much interest the implementation of the LaQue report, a document that has contributed to all our thinking.

Standards as Help or Hindrance to International Trade

All standards record a consensus. Standards codify the wisdom of many. There are now about a thousand standard recommendations of IEC and the International Standards Organization, ISO, recording a world consensus on a remarkable range of detailed topics. These include standards for machines and materials, methods of test and analysis, and means of communication, including glossaries, codes and units. No other area, as Mr. McCune has said, of human affairs has produced such an extensive and detailed record of consensus. There are, however, many thousands of national standards, often enforced by legislation or national exclusive testing or approval arrangements. These national standards quite frequently offer formidable barriers to trade between countries.

It is a thesis of this paper that it is urgent for technologically advanced countries to exercise more leadership in extending the world technological code embodied in world standards, and that it is in the interests, both of advanced and developing countries, that this should be done. This great occasion offers us the hope that these new laboratories will contribute to this purpose.

Information on standardization is manifestly more important to smaller industrialized countries which devote a higher proportion of GNP to exports. For example, the United Kingdom exported 14 percent of its GNP in 1964, while the U.S.A. only exported 4 percent. In the same year, the Netherlands exported 35 percent.

Of course, the flow of trade between the States of the U.S.A. is not international trade and is subject to few restrictions. In contrast, the flow of trade between the States of Europe is international and subject to many obstacles. Who can doubt that the impediments that there have been in Europe to the free movement of people and goods provide at least a small part of the explanation for the lower standard of living in Europe compared with the U.S.A. Differing standards, both voluntary and compulsory, are obstacles to trade that are often overlooked in the preoccupation with tariff barriers.

International standardization is necessary for the removal of barriers which often impose more restrictions on trade than do tariffs, but the profit to be harvested from international standardization is almost certainly greater in Europe than in the U.S.A. Europe has the larger problem but the less saturated markets. However, all countries, including the U.S.A., are becoming more dependent upon their foreign trade.

Harmonization of International Trade

Where is the driving force for increasing the pace of international standardization activity? One great force is that of the Common Market countries, anxious to harmonize their trade. These countries, with a total population similar to that of the U.S.A., have what may be described as an economic gravitational field. The United Kingdom and other members of the European Free Trade Area are within that field, in orbits of apparently diminishing diameter.

The developing countries, anxious to benefit from the best advice and to reduce the difficulties of multiple standards from which they already suffer, are another force. An increasing number of developing countries, particularly the new African states, are

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Born in 1910, Mr. Wynn received his education at Oundle School and Trinity College, Cambridge, where he was an Entrance Scholar in Natural Science and Mathematics. After granting of his M.A. Degree, he qualified as Barrister-at-Law.

He worked for A. C. Cossar Ltd. in the electronics field from 1939 to 1948, at which time he assumed the position of Director of Safety in the Mines Research Establishment of the Ministry of Fuel and Power. From 1955 to 1965 Mr. Wynn was Scientific Member of the National Coal Board, serving at the same time as a member of the Advisory Council on Research and Development of the Ministry of Power. He was also a member of the Safety in Mines Research Advisory Board during the period 1950 to 1965.

within the gravitational field of the Common Market. These developing countries will generally adopt international standards and not the standards of any particular developed country.

The greater concern of Europe with international standardization is to be seen in the location of the secretariats of the ISO and IEC technical committees. Of the 242 ISO technical committee and subcommittee secretariats, the six countries (Belgium, France, Germany, Holland, Italy, Luxemburg) of the European Economic Community (EEC) together hold 119, the United Kingdom 38 and the U.S.A. 60. Of the 133 IEC technical committee and subcommittee secretariates, the European Economic Community (EEC) holds 69, the United Kingdom 26 and the U.S.A. 13. The United Kingdom, represented by the British Standards Institution, has been among the first two or three nations in its contribution to international standardization at all times. There are also international "Standards" organizations, for example, the International Organization for Legal Metrology (O.I.M.L.) to which the United States has not hitherto belonged.

I cannot claim to understand all the obviously severe restrictions on the full participation of the U.S.A. in world standardization in the past.

The elimination of the barriers between the six Common Market countries and the removal of obstacles to trade are express purposes of the Treaty of Rome, which established the European Economic Community or Common Market. This is part of the process now generally known as harmonization. The acceleration of standardization has been interpreted as an essential part of this policy of harmonization. The Treaty of Rome is removing all barriers to trade within the Common Market due to differing national standards, disparate legislation or purely national testing or certification arrangements. The initiative in international standardization comes, however, mainly from the individual countries rather than from the organization of the Common Market.

We are reacting to this in the United Kingdom. The confederation of British industry, which is a federation of all trade associations, speaks for British industry as a whole and has urged the British Government to "support, and be seen to support every attempt to secure international alignment of standards in the appropriate international forum. It should, moreover, both in its own legislation and in its procurement policies, give the strongest support to acceptance of internationally agreed standards as British standards without deviation."

The seven countries of the European Free Trade Area have been much concerned that the deliberations within the Common Market should not lead to new obstacles to trade between the two blocs, and the seven governments who belong to the Council of Ministers agreed at Bergen in May 1966 that: "The Ministers should give strong encouragement to industries, departments, and to standards bodies to pursue the objective of early agreement on standards in the European and, where appropriate, in the international standards organizations.

The national standards bodies should be pressed to make the strongest efforts to secure full acceptance of these agreements in national standards without deviation, and public purchasing departments should be urged to take full account of such standards."

The standardization activity of the Common Market countries is not only of concern to Europe because the results influence the deliberations of ISO and IEC very quickly and are indeed often intended to do so. European countries are strongly represented on every committee and therefore are in a good position to influence ISO deliberations.

Technical Areas Affected by International Standardization

The pace of international standardization is increasing. In the last 10 years ISO produced about 500 recommendations. It is hoped to produce over 100 in 1966 alone. ISO is being expanded, and it is planned to produce 200 in 1967 and more than 300 recommendations a year from 1969 onward.

On what subjects is this international standardization activity particularly concentrated? The greatest activity in most countries is concentrated on compulsory national standards. It is widely believed that these national standards enforced by law are the greatest of all obstacles to international trade. These standards have received the special attention of working parties of the Commission of the Common Market under the general heading of "Obstacles to trade arising from provisions of a technical order." These working parties have, for example, produced 12 Council Directives concerned with motor vehicles and 5 with agricultural tractors.

Motor Vehicles

Conformity with these standards is likely to become essential to any manufacturer wishing to sell a vehicle or tractor within the Common Market. Alignment of EFTA with Common Market standards and extension to African associated States and

Greece and Turkey may increase the purview of these directives eventually beyond the six members of the Common Market.

These motor vehicle and tractor standards have built into them operational experience, engineering knowledge and research results. They also record a consensus about the price that is worth paying for increased safety. There seems to be no good reason why motor vehicle standards vary much from one country to another. Certainly the greater the pool of experience, knowledge, and research results underpinning the standards, the better they are likely to be.

There is everything to be said, therefore, for discussing such standards in as wide a forum as possible and for a constructive dialogue between Europe and America, with a pooling of wisdom and experience. Indeed, the failure of this dialogue to proceed fast enough in the past and the unilateral action on both sides of the Atlantic already taken or about to be taken, seem certain to result in substantial further losses in trade to most manufacturers.

Twelve years ago it was only necessary to produce two versions of an automobile for sale to Europe. Today, in spite of excellent work of the Economic Commission for Europe, it is necessary to produce 9 or 10 versions. The barriers to trade are growing. Regulations governing motor vehicle design are essential but it is not clear that anyone benefits from compelling manufacturers to produce a dozen different designs for different markets. Nor is it clear that the cost of international negotiations could ever be at all comparable to the losses to countries, including the United Kingdom and the U.S.A., who manufacture motor vehicles, caused by disparate regulations, and motor vehicles are, of course, only one area where trade is impeded by disparate regulations.

Foodstuffs, Food Preservatives and Proprietary Medicines

The Council of the Common Market has issued directives concerned with coloring matter in foodstuffs, food preservatives, and proprietary medicines. Directives concerning preservatives, for example, came into force in November 1965. The directive explains that it "is necessary with a view to the free circulation of commodities intended for human food," but the primary concern, of course, is with free circulation within the Common Market. More than a quarter of the world's trade is in this area of food and drugs. Every country has its food and drugs legislation, and it can be sound only if based upon research that is generally costly, indeed, so costly that it can only be afforded by the most advanced nations. There is everything to be gained by aiming at a world consensus about each individual coloring matter, insecticide, herbicide, preservative or drug.

The advanced nations generally need world markets to help pay for the research and if expensive duplication of research beyond the means of most nations is to be avoided, then the smaller and poorer nations must rely on the research undertaken by the few.

The international standards for food and drugs, including insecticides and herbicides, are of primary economic importance and must be a major object of future research.

Safety and Health

Insofar as the purpose of technological advance is improvement in the human condition, then the improvement of safety, health, and amenity are an essential part of that purpose. In the standardization activities of governments, and these European governments in particular, there is nevertheless a double motivation. There is the urge for harmonization in order to satisfy the need of modern industry for a large market, a need that flows from the economies of scale and from the falling real cost of transport, due in part to the increased value of many manufactured goods per unit weight. Harmonization is a profit-generating activity, more particularly for the large, low cost producer. This is the first motive.

Harmonization has, however, to be consistent with the public will for promotion of safety, health, and amenity, which has been government's traditional concern with standards. This public will provides the second motive.

The formidable barriers to trade have resulted from compulsory national standards and have not generally been erected primarily to protect indigenous producers but have resulted from the essentially national or even local character of legislation concerned with health, safety, and amenity. This legislation will remain national and local. The barriers to trade can still be removed if legislation is increasingly based upon international standards. If there is adequate international cooperation to ensure that these standards reflect the best possible world opinion, then the quality of the local legislation may often advance more rapidly than hitherto.

Many barriers to trade cannot be removed by international standardization alone. It is also essential to have international testing and inspection conventions. This is necessary because the screening out of equipment that is unsafe or dangerous to health should not be left to market forces but should be made the job of an expert organization backed by national legislation.

The difficulties of exporting any kind of pressure vessel to many countries of the world, including the U.S.A., are well known but are still daunting. This is a very old problem. The United Kingdom now has reciprocal testing and inspection arrangements for pressure vessels with a number of European and Commonwealth countries, without, however, having yet harmonized the standards. The United Kingdom would welcome such reciprocal arrangements with the U.S.A.

Electrical Equipment

Some of the worst hidden barriers to trade concern electrical equipment. Almost all electrical equipment exported to some countries has to conform in such matters as the adequacy of insulation or rise of temperature and has to be approved as conforming.

In the Scandinavian countries a safety mark is compulsory by law. In the official showrooms of power authority suppliers. in France, only products bearing the NF mark are allowed. There are many main plugs and miniature plugs. A dozen or so different models of radio receiver, vacuum cleaner, or electric iron are necessary for export to European countries alone.

There are Common Market directives in draft concerning low tension electrical equipment, household electrical equipment and portable electric tools.

The Common Market Commission can rely on the ground work that has been done by the International Commission on Rules for Approval of Electrical Equipment, usually known as CEE. All the 18 member countries are European, although the United States has sent observers to meetings for the last 17 years. The CEE is a powerful code-making organization, concerned not only with safety standards for electrical equipment but with compatibility, and it is perhaps likely in the future to be increasingly concerned with standards of quality and reliability. We do not understand why the U.S.A. has felt for 17 years unable to give full support to this barrier-removing organization.

Conformity with performance requirements cannot be established by visual inspection, and a standard testing procedure is generally needed. The CEE will issue a certificate of compliance with CEE specifications for any equipment if advised to do so by the testing station of the country of manufacture and of one other country. The certificate is then accepted in all 18 countries. This is an outstanding international agreement for reducing trade barriers.

A few other conventions exist, but very few. The British Standards Institution, for example, is recognized by arrangement with the Canadian Standards Association as a testing and inspection body for all British electrical equipment exported to Canada. There is no such reciprocal arrangement between the British Standards Institution and any organization in the U.S.A. What organizations in the U.S.A. can be parties to testing conventions with, say, CEE or BSI? Is this one of the future roles of the United States of America Standards Institute? It will be interesting to know whether the U.S.A. already has any reciprocal testing or certification conventions with other countries or whether there are any new conventions in mind.

Quality Assurance and Performance Criteria

The need for testing conventions is not confined to electrical equipment or problems of health and safety. There is a great interest in Europe for schemes in quality assurance. The distinguished report of the National Commission on Technology, Automation, and Economic Progress, entitled "Technology and the American Economy," placed great emphasis on the use of a performance criteria as a means of promoting technological innovation and advance.

The same emphasis on performance specification is evident in Europe and in the United Kingdom and is likely to be reflected in international standards. The international implications of this great emphasis on performance criteria still need, however, to be thought through.

The economic role of performance specifications in our competitive market economies also merits discussion. Performance specifications can be used to reinforce market forces and strengthen the market economy, and can also be used restrictively.

Test specifications may be used only to disclose performance facts to buyers, and so to increase their power of discrimination. Specifications used in this way strengthen and accelerate the action of market forces in eliminating the inferior and promoting technological advance. This is a role of performance specifications which we regard as wholly beneficial to a free economy.

However, test reports that include opinion, even expert opinion, can bias consumers' choice, and are in a sense restrictive. Performance specifications can also provide the basis of legislation. It is a tradition in the United Kingdom only to use such legislation to promote safety, health, or public amenity, for example, under the Factories or Mines and Quarries Acts.

Some new schemes in the United Kingdom directly concerned with performance specifications and testing already have international implications. For example, there is in the United Kingdom an association of big purchasers of instruments, mostly of the type used in the processing industries, that "evaluates" instruments. This is an essentially permissive scheme for reinforcing market forces. The instruments are tested in the laboratories of the Scientific Instrument Research Association for conformity to performance specifications agreed between user and manufacturer. Factual reports are produced and circulated to members. The costs of quite expensive tests of new instruments are spread in this way over the members. There is now a similar association in the Netherlands and the recent agreement between the United Kingdom and the Netherlands Associations to accept each other's "evaluation" reports. This is an interesting example of a quality assurance scheme that has been established on industrial rather than government initiative and on the initiative of industrial consumers rather than manufacturers.

Not only British but American and continental instruments are tested for conformity to specification, including accuracy and reliability. The scheme illustrates a growing concern with quality and reliability, particularly of on-line process equipment, and also the growing cost and difficulty of choosing the right equipment for the job. Both the industrial buyer and domestic consumer are increasingly concerned with this problem of choice over a range of equipment much wider than industrial instruments.

There is another quite separate scheme in the United Kingdom for the evaluation of new building components and materials. This is quite similar to the French scheme for the testing and approval of building components. Both schemes are concerned essentially with promoting progress in building and construction by using performance criteria for screening new developments.

The French scheme was motivated by insurance requirements for new buildings; the British scheme was initiated by Government for the purpose of accelerating acceptance of new building techniques and reducing variety in favor of the better building techniques. Reciprocal approval arrangements are in mind. There is an element of compulsion in this scheme, as each certificate is deemed to indicate compliance with building regulations.

There is a separate, well-established scheme for the performance testing and evaluation of agricultural machinery in the United Kingdom by the National Institute of Agricultural Engineering.

These new schemes are part of a spectrum of activity that provide consumers, including industrial consumers, with quality assurance. Such schemes, unless well conceived, have their dangers and can introduce further barriers to trade.

The national standards organizations are much concerned with quality assurance and have associated national marks, such as the BSI Kitemark in the United Kingdom, the NF mark in France and the JIS mark in Japan.

Generalizations about the economic role of these marks are liable to be wrong, as they have many purposes. When applied to some products such as crash helmets or life belts they are often rightly compulsory and restrictive, but when applied, for example, to metal finishes or the composition of alloys they are permissive and informative and a valuable help to the market. These well-known marks all indicate conformity with some national standard. The use of the mark is generally based upon approval of a manufacturer's quality-control procedures or on procedures agreed on by a whole association of manufacturers. For some products, samples have to be submitted to independent test.

Conventions between nations for the reciprocal acceptance of the marks of their standards bodies are conceivable and have indeed been discussed but in general no conventions exist. There are, however, models to be followed, including the testing procedures already mentioned of CEE, and the Anglo-Dutch arrangements for the evaluation of instruments.

An extension of these schemes concerned with quality assurance is certain. There seems to be no reason why evaluation techniques of the kind already used for quite complicated industrial control equipment should not be extended to cover computers and ancillary equipment and communication equipment, including satellite equipment and even civil aircraft.

Such schemes could be extended internationally. The essential requirement is always an objective specification defining the tests to be performed, preferably agreed between manufacturer and customer. There is much to be said for the manufacturer having the right to veto the publication of a report if he wishes. This is in fact what we are generally doing. A satisfactory performance specification can hardly ever be written except at the end of an experimental program.

Performance specifications for oil-hydraulic equipment, or bearings and lubricants, or electronic components, or almost all components or finished equipment of industrial importance can be written only at the end of an experimental program that may be expensive.

The production of sound performance standards depends indeed upon an intimate knowledge of what is possible as well as what is needed. Such knowledge is generally to be found only within the frontiers of the technologically advanced nations, and notably within the U.S.A.

This is, therefore, a particular point where the world needs the leadership of advanced countries.

Barriers to Communication

All the barriers to trade that have so far been discussed in this paper, including performance standards, are concerned with end products of technology and their suitability for use. Barriers to communication are probably of comparable economic importance, and the long history of standards is primarily concerned with problems of communication. No commercial transaction at a distance is possible without standardization of word meanings and units of quantity. These problems include the provision of basic and derived standards of measurement and their transfer, the language of units and indeed the language of science and technology, the new languages of data processing and transmission, institutional structures and procedures used by such organizations as ISO and IEC, and much else besides.

The technology of the world advances by the diffusion of technology from discrete innovating centers. The rate of economic advance of all nations depends very much upon this rate of diffusion of new technology. The smaller and developing nations are heavily dependent upon diffusion of this knowledge from outside their frontiers. International standardization makes a double contribution to this diffusion of knowledge. Standards are authoritative statements about technology, but standards are also concerned with processes of communication.

The U.S.A. has played a very leading part and has a special responsibility to the ISO for nuclear energy standards. Various organizations may be said to be planning the diffusion of new knowledge about nuclear engineering to the future owners of nuclear power stations.

Traceability

The communication of standards of measurement can also be planned. Traceability is a word that was born in the U.S.A. in the 1950's. Standards of measurement are, of course, of no use unless they can be communicated. Many measurements inevitably lose accuracy in the course of communication. The art of communicating measurement standards is, therefore, itself a proper object of research, and in due course of the standards code defining the method of transferring, say, a measurement of radio frequency power from a central national institution to the manufacturer's standards laboratory.

The greater use of atomic definitions of units could reduce the problem of communication.

In the United Kingdom we have followed with much interest the work of the National Conference of Standards Laboratories in the U.S.A. We are creating a British Calibration Service in the United Kingdom with a somewhat similar purpose but also with the ambition of giving meaning to the word "traceability." I hope that we may before too long have a series of standards as a foundation of traceable chains for many classes of measurement.

Technology is demanding ever higher levels of accuracy for a wide range of measurements. This accuracy is required on the job in many parts of the world. The communication of a measurement to the point of use, or the diffusion outwards from central laboratories of measurement capability, is a large part of the problem and purpose of the British Calibration Service. The end of this development must be a much extended matrix of laboratories in the world as a whole, with measurements traceable to a few central laboratories and ultimately to the laboratories of the BIPM.

The concept of traceability as applied to measurement derives not so much from the location of ultimate standards as from a greater capability in a given location as a consequence, for example, of superior equipment.

The application of the concept of traceability can therefore be extended notably to materials of high purity or special composition. Traceable measurements are needed throughout industry, defense and commerce. The Common Market has given priority to the needs of commerce and there are now a number of draft Council Directives to the Common Market concerning weights and measures.

International System of Units

During recent years the world has gone far towards the adoption of an international system of units, or SI units. Perhaps the most important thing about units is to use them to help international trade and not to allow them to obstruct the adoption of international engineering and commodity standards. In the United Kingdom we know that we shall have to continue to live with both the SI and the English or Imperial system for a period. We are, however, adopting the metric units at points where it is believed that they will help and not injure the economy. This requires much study and consultation and the results are often surprising.

The concept of a module, for example, is particularly important in the building and construction industry. In the U.K. it has been decided to adopt a 10-centimeter module. Thirty centimeters will also be a preferred dimension. No compulsory legislation converting the whole economy to the metric system is at present in mind, but rather the use of the metric system and SI units for increasing numbers of limited purposes, like its present use in the motion picture industry for film standards. Electric motors are a particular example of an early change.

Units are just one contribution of standards to the art of communication. Of even greater importance in the future will be the standards for data processing and transmission. The ASA has made an outstanding contribution introducing American standard FORTRAN. The U.S.A. holds the secretariats for IEC Technical Committee TC-53, Computers and Information Processing, and TC-53(b), Digital Data Transmission, and is therefore in a unique position to influence and accelerate production of world standards for data processing and transmission. Work is needed urgently to control the proliferation of new words and acronyms.

We may perhaps anticipate a great need for performance criteria for both computer equipment or hardware and for software, to give confidence and facilitate trade across national boundaries. Design standards are necessary for electrical connections, data format, and speed of transmission in terms of error rate and so on.

The most serious problems, however, may concern the man-machine relationship. The development of software sophistication may eventually require more direct man-machine communication, while details of the machine code and operating system will be looked after by the compiler and executive and will be of no interest to the user.

These developments may bring to the fore the great problems of national language differences, particularly if the maximum international use is to be made of facilities.

Information storage and retrieval will grow in importance with bigger storage banks in different countries able to interchange information. Standard methods of indexing and recording will be essential. There is perhaps no bigger area of new problems. There should be much scope for close collaboration between the Ministry of Technology and Department of Commerce's new Center of Computer Science and Technology in data processing and transmission.

ISO and IEC

The central administrations of ISO and IEC are not commensurate with their great responsibility and they are to be strengthened, for this reason. The separation of ISO and IEC is perhaps also a weakness to be overcome in due course. The investment in these organizations by advanced nations will still, however, amount to no more than a small fraction of one penny, or one cent, per annum per head of our populations. Is the possible contribution of these organizations to reducing trade barriers really so marginal? Do all our other investments abroad in developed and developing countries really produce a higher return?

The main staff work can, however, never be centralized. The main contribution of individual nations may probably come through the secretariats, like TC-53. Much can be done by technical committee secretariats, by informal discussion and correspondence, to establish world consensus in advance of formal meetings. It is increasingly necessary for each secretariat to be supported by a specialized information center, and these information services should be available to the central offices of ISO and IEC. Many programs will also require laboratory support. Indeed, the secretariats that we hold should influence the staffing of our organizations in research and development projects. All of us who hold technical committee secretariats have an exacting task to win the confidence of other countries, both in our technical ability and our intentions.

International Standardization Activities in Various Countries

The Soviet Union and other countries of Eastern Europe do not hold many technical committee secretariats, but they do make a great contribution to international standards activity and are to be numbered among the countries whose confidence has to be won.

The United Kingdom has frequently been in the lead in international standards activity. We believe it has been a good investment for us. In the United Kingdom, insularity is in decline.

It is still a very difficult matter to decide upon the right balance between activities aimed at achieving national and international consensus. We appreciate that it is more difficult to decide upon the right balance for a country as large as the U.S.A. However, the world will lose much unless the variety of organizations concerned with removing technological barriers to world trade receive the full support of the U.S.A.

There is a great spectrum of activity, oversimplified in this paper, needing international collaboration and your help. The United States of America Standards Institute and the National Bureau of Standards, supported by the finest standards laboratories in the world, will, we know, bring great benefit to the U.S.A.. and will, we hope, also make a contribution to world standards activity commensurate with the great contribution that the U.S.A. makes to world technology.

QUESTIONS FROM THE FLOOR

Dr. Astin: Thank you very much, Mr. Wynn. Both Mr. McCune's and Mr. Wynn's papers are now open for discussion.

Mr. Podolsky: My name is Leon Podolsky from the Sprague Electric Company in Massachusetts. I address myself to Mr. Wynn. He has asked a number of provocative questions. I am going to limit myself to just one—his remarks with regard to CEE membership.

He commented that in 17 years the United States has been only an observer to CEE. It is our understanding that the charter and national legal basis for CEE has in all this time actually precluded membership by the United States in the CEE and nothing more than observer status is available to us. Would you care to comment on that, sir?

Mr. Wynn: I went into that myself and I got the answer that the USA was not precluded from joining; I would comment further that all constitutions can be changed.

Mr. Podolsky: For 17 years we were welcomed as observers but not as members with a vote.

Mr. Wynn: We will give the USA every support in trying to change the constitution accordingly.

Dr. Astin: Are there further questions or comments?

Question: How much progress has been made in standardization and communication of standards between Eastern Europe and Western Europe?

Mr. Wynn: As far as we know, the countries of Eastern Europe are very quick to adopt ISO and IEC standards, but I believe there are people here from Eastern Europe who can reply better than I can. I think of all the countries in the world they respond extremely quickly in enforcing and adopting international standards, once agreement has been reached, and they fully cooperate in the standards committees of ISO, IEC, and so on.

Dr. Astin: Would you care, Mr. Sharpston, to comment further on that point?

Mr. Sharpston: Yes, Mr. Chairman, I would confirm the substance of that last remark. I have had this directly from the ISO staff and the members, that in their work they do very rapidly adopt the ISO recommendations where these are favorable, this being particularly true in their own regional grouping.

Dr. Astin: We will now have our topic discussed by four experts on the subject of standardization. The first of these is Mr. Fayvel Hadass, who is the Director of the Standards Institution of Israel.

Mr. Hadass: Dr. Astin, Ladies and Gentlemen: I am not supposed to take more than five minutes of your time. In five minutes or 300 seconds in the non-decimal system that are at my disposal, I wish to bring some fragmentary comments related to the aspect of developing countries.

Looking back at the past 50 years, two events are most conspicuous; the immense technological advancement so well described by Mr. McCune, and the awakening of a very considerable part of humanity to their economic potential. No doubt, both phenomena are interrelated.

Looking ahead, we are facing two imminent world trade factors: One—Through further technological advancement, the plenty of today may, under peaceful world conditions, turn into a disturbing surplus. This is not unlike the surplus brought about by industrial farming. Second—The awakened part of the globe can and is going to be turned into the potential recipient for this surplus. A first family car in Africa will be a better choice for the surplus automobile than the third family car in the producing country.

It is therefore the concern of the highly advanced countries to promote the buying power of these potential markets. In order to become paying purchasers they must produce added values. Here, technology can assist them in becoming a productive and constructive world trade factor. What I have in mind is applied technology, since sophisticated scientific technology is going to remain for a long time the domain of the most advanced nations. In young countries, sophisticated technology often results in prestige ivory towers. A baby should be fed milk, not steaks!

An important tool of technological advancement is no doubt standardization. It is of utmost importance particularly to developing countries as suppliers as well as purchasers in the world market.

—It helps them to establish, right from the beginning, an adequate quality of production.

—It helps them to become discriminating buyers, thus intelligent spenders.

—It offers them a kind of clearing house in the complex of world trade.

—It also offers to the beginners the benefits of knowledge and experience accumulated in the existing standards.

Developing countries are particularly interested in *international* standards. They can and will develop their national standards, mostly those related to their specific natural, social and technical conditions. But in foreign trade, for all practical purposes, they are dependent mostly on standards of the buying and even selling advanced countries. The bitter taste of "colonial quality" is still fresh in the minds of Africa, Asia and Latin America. Naturally enough, they find international standards, based on world consensus, more just and reliable. The more so in the role of suppliers of raw materials and semi-finished products.

It is in the interests, also, of the industrialized nations to help the developing part of the world become standard-minded and assist them in setting up standardization and testing facilities.

From what I have been able to learn in the pilot-plant-sized economy of Israel, differing standards, the dualism of systems and the inadequate coverage of international standards are—*always* a nuisance, *usually* a waste of time, energy and money, *often* a serious trade barrier. I will illustrate with two examples—62% of the Israeli plywood production is being exported. Our national standard provides for 47 size varieties. Because of the lack of an internationally agreed-upon standard, we have to deliver many hundreds of sizes. —At the conference table of an international committee, the Indian iron ore export just increased its return by a full percent—, by millions of dollars.

May I address a few words to my hosts? From observations collected around the globe, I sincerely conclude that the most advanced and standard-minded American technology is still detached, to a regrettable extent, from international standardization activities. I am convinced that you could give and take much more in international trade through closer cooperation in this area. If world trade is to be really free, smooth and decent, it is imperative to develop a global and uniform trade yardstick—to my mind, a meter-stick.

Those who are qualified for leadership have to place the horse before the cart—and act early and decisively!

When Lindbergh crossed the Atlantic, the rabbi admired his skill and courage, but failed to understand his hurry. Today, all of us are in a hurry—even the rabbi travels by plane.

FAYVEL HADASS *is Director of the Standards Institution of Israel. His industrial experience began in Danzig in the automotive industry. Upon his emigration to Israel in 1932 he spent seven years on the mechanization of farming. During World War II he spent four years on the development of the local industry for the War effort and served as Member of the Allied War Supply Board.*

For the subsequent four years Mr. Hadass was active in international trade with an American firm. With the establishment of the State of Israel he became Controller of Light Industry and a Member of the Board of the Investment Centre, as well as adviser on industry to the Ministers. He founded, and for four years managed, the Institute for Vocational Safety.

Mr. Hadass has been associated with Standards work for seven years and he is a Member of the Board of the Institute for Productivity.

Dr. Astin: Our next discussant is Mr. Francis L. LaQue, who is Special Assistant to the President of the International Nickel Company of Canada, Limited, and a Vice President of the International Nickel Company, Incorporated, assigned to executive support of major corporate activities.

A short time ago he headed a distinguished panel under the Commerce Department's Technical Advisory Board to study our national needs with respect to standards. His report is well known and has been widely read and discussed and I think was a major factor in the recent organization of the United States of America Standards Institute. It is my pleasure to present to you Dr. LaQue.

Dr. LaQue: Thank you, Dr. Astin. Distinguished guests from abroad, ladies and gentlemen: I will take the risk of telling a story that might be considered to be funny to some people, and it has a moral. The story is this.

There were a lady and her husband walking down the street. The lady noticed a weighing scale in a doorway. She went over, got weighed and came back with smiles all over her face.

Her husband asked her, "My dear, how much overweight are you now?"

She said, "I am not overweight at all. There is a chart in there on that scale, and according to that chart I am 6 inches too short."

The moral is obvious, of course, that when relationships are indicated between one measurement and another we cannot safely assume the interpretation of this relationship is going to be the same by everyone who endeavors to make it, and I would think that the danger in this direction is likely to increase with the international use of any such systems of relationships.

I assume that the ground rules will permit me to deal, in my occupation as discussant, with matters that were presented this morning as well as this afternoon. I was particularly interested in trying to prepare a discussion in advance of what I thought Dr. McLuhan might say. That was an interesting activity, so in preparing my comments an immediate problem was presented in trying somehow to relate anything as "hot" as precise standards documents to the "cool" world which Dr. McLuhan visualizes as being imminent and perhaps desirable. The words "hot" and "cool" are used in this context in the sense that the speaker has tried to understand Dr. McLuhan.

Precision and Uniformity in Standards

In the field of international trade, in which standards are an essential component of the language of communication, it is likely that everyone will agree that 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.

The ability to describe what is wanted and what is offered very precisely become more and more important as the revolution in means of communication progresses. It is already possible to transmit facsimiles of printed documents overseas in a matter of minutes. When such means of communication take the place of discussions at first hand, the need for precision in description of what is being dealt with becomes greater and greater. Along with this need for precision is an almost equal need for uniformity of standards on an international scale. Thus, advances in communication techniques increase the urgency of the development of international standards as a vital factor in world trade.

The standards I have been discussing apply, of course, to things that are prescribed in terms that describe exactly what is to be furnished, keeping in mind the purpose for which it is to be used. These precisely descriptive standards or specifications must of necessity fall into what Dr. McLuhan would consider to be a "hot" category.

Performance Criteria

On the other hand, we can see a trend toward another type of standard or specification which prescribes what is wanted in terms of the performance needed or expected, without stipulating how this performance is to be achieved. This begins to approach Dr. McLuhan's realm of the "cool", since it implies a degree of freedom—if not exactly free-

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A native of Ontario, Canada, Mr. LaQue received his Bachelor of Science Degree in Chemical and Metallurgical Engineering from Queen's University, Kingston, Ontario in 1927, and an Honorary LL. D. from that University in 1964.

wheeling—in which display of imagination and new approaches are favored in the "cool" atmosphere of cultivated vagueness, which the speaker guesses Dr. McLuhan would welcome and endorse.

It seems reasonable to recommend that our attitude towards the nature of standards and specifications should remain fluid, so that the advantages of any sensible approach can be examined and utilized on a rational basis, in what Dr. McLuhan might describe as being a "cool" way to do it. We must, however, continue to use the "hot" line whenever it is impossible or impractical to employ the "cool" approach and when there are no reliable means either to define adequately the circumstances of the intended use or to measure performance capabilities closely enough to permit the use of a performance standard in preference to a descriptive one.

The tremendous capability of the National Bureau of Standards, as represented by its staff and its new facilities on display on this occasion, is being applied more and more to the development of new and better means of measuring performance as well as properties of materials and things that enter world trade. This is bound to accelerate greater use of performance as compared with descriptive standards and specifications, and thus we shall feel more and more at home with our standards in the new and "cooler" world in which we are going to be living.

I have some additional comments pertinent to some of the questions raised this morning and comments made.

Technology flows in world trade through the substance of engineering and material standards and methods of test, which include the distilled product of the tremendous amount of research upon which these standards are based. This will be a means by which the developing nations can be given the advantage of the technology of the nations in which the most sophisticated standards originate and appear in their most highly developed form, most useful to developing nations—that is, international standards. This requires, of course, the existence or cultivation of an ability to make use of knowledge provided in this form to the developing nations.

Systems of Measurement

I have another comment dealing with occasional presentation of statistics relating world trade to systems of measurement. Statistics on possible effects of systems of physical measurement on international trade ought to be refined, to make a proper distinction between items where the size module or system of measurement is likely to be important—for example, a component of manufactured goods as distinct from a complete assembly such as an automobile or a machine, and as distinct from those where no significant effect is likely such as foods, fuels, and raw materials.

It is easy to understand that the problems presented by a change in the system of measurement will be least in the case of measurements of weight and volume and greatest in the case of linear measurements as applied to machine components, and here the problem is not so much one of the units used for measurement as it is the size that is measured. We speak of international cooperation in achieving uniformity in the realm of measurement and I would hope that we could look forward to a lot of give and take, in which the module sizes already well established with the one system might be accepted in other areas in return for the acceptance of the unit of measurement on an internatioal scale.

I recall that in Mr. Wynn's paper he referred to the desirability of bringing to bear on safety standards the accumulated knowledge, wisdom and experience of every country, rather than to develop such standards on an individual country basis. I think this is merely an extension of what I believe is the most important factor in the development of safety standards in any country, which is not to waste time debating where the dominance of development of such standards should rest, but to try somehow to find the best way to organize competence from every available source.

Dr. Astin: Our next discussant is Mr. Samuel H. Watson, who is Manager of Corporate Standardizing of the Radio Corporation of America.

Mr. Watson: Dr. Astin, distinguished guests, both from our many friendly countries abroad and the United States:

Standardization is recognized and firmly established as an essential function in government, in the military and in industry. My identification is predominantly with industry, where the pursuit of standardization can be difficult, costly, and limited in effectiveness unless it is a team effort which includes Government and the Department of Defense. The areas of mutual interest are extensive. Teamwork is in effect in many committees at the national level and because it is, more and more standards are appearing with a stamp of universal approval and acceptance. They are the product of hard-working, objective, and highly dedicated people; they are truly United States of America standards. They clearly identify United States of America positions on the subjects resolved, and they equip U.S.A. delegations well with the documentation and the authority needed for effective participation in international standardization.

Coordination of Standards

Thoroughly coordinated standards are needed in greatly increased numbers. To this end, the function of the reconstituted American Standards Association under the new and appropriate name, United States of America Standards Institute—if its function can be briefly stated—is: "to provide the coordination, the procedures, the administration and the centralized services needed to accelerate the production *and maintenance* of United States of America standards and to establish and maintain appropriate USA participation and effectiveness in world standardization." The capacity of the Institute to carry on this important task will be markedly increased with the granting of the proposed Federal charter.

Standards as Aids to Communication

The standards in greatest need internationally are those that can make a contribution to improved communications, a contribution in each case that is worth the effort and expense required to bring it about.

One of our great international standards, a boon to communications and world trade, is the Gregorian calendar. Occasionally a proposal to change it is publicized. Perhaps the change is convincingly explained as one offering some improvement in communications. However, since the existing calendar is working so well and since it took almost 400 years to get it into universal use, it is not likely to change in the near future.

In any avenue of international communications, where all those involved readily understand one another, further purification of the basic standards of communication is not likely to affect world trade to any measurable degree. Conversely, changes in existing standards or newly introduced standards which can substantially speed-up and sharpen understanding among the representatives of different countries can have far-reaching effects upon world trade.

Such standards are a most favorable influence toward improved utilization of world manpower and material resources. Standards in this latter category are the breakthroughs, the difficult standards to come by. Included would be any standard, practice, or procedure that softened the greatest obstacle in the conduct of international transactions—the language barrier.

Perhaps the near future will bring an ingenious way of accelerating the already somewhat advanced merging of languages. Probably few of us in the English-speaking countries realize how much French we know until we thumb through an English-French dictionary. In the same vein, if others share my experiences, it is disturbing when using an English dictionary to note how much English we do not know.

I stated that standards that improve communications are most important. Through them, the peoples of every nation will better understand and better evaluate the standards and offerings of other countries; each in terms of its own economic needs and preferences. As a result, it is likely that a degree of variety and not global sameness will continue to prevail.

The trends in color television preferences in the countries of Europe today provide an excellent example. Color television receivers will be powered by a variety of voltages and frequencies, the pictures will contain a varying number of lines per frame,

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Mr. Watson, is a Senior Member of the Institute of Electrical and Electronic Engineers, and charter member and Fellow of the Standards Engineers Society. In recognition of his service to the voluntary standards movement through leadership in the actual development of standards, that organization awarded Mr. Watson its ASA Standards Medal in 1962.

Mr. Watson was the U.S. Representative to the ISO Committee on Drawings in Geneva, Switzerland, that year, and was Chairman of the U.S. Delegation to the meeting in Budapest, Hungary, in 1965.

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and the broadcast signal standards will conform to one of possibly three different systems.

Importantly, however, the basic standards of measurement are essentially identical. This enables all the countries of Europe, regardless of power, broadcasting, and receiving practices to use the same standard materials and components in the manufacture of television equipment.

Although the European color television receiver owner may not have access to certain programs, he can fully enjoy, in the programs he does receive, the reliability and fitness-for-purpose developed in the United States over a number of years of high volume color TV component production and field experience.

Critical Approach to Standardization

I stated that standardization is recognized and firmly established. This means that it is here to stay, and more and more will be expected of it in government, in the military and in industry. Funds and management support for standardization are being made increasingly available. With them will come demands for high performance levels; the maximum of effective standardization for each dollar expended. The standards engineer of the future, like many today, must be a very competent fellow with his feet firmly on the ground, a healthy and controlled enthusiasm for standardization and a capacity for effectiveness with people as well as with technical problems and situations. The standardizer who waves the banner and gets carried away will require increased restraint.

In recent months, in my reading, a new stumbling block has been added; the word "Hertz." I refer to the adoption of Hertz for use instead of CPS (cycles per second) and not to the well known automobile rental agency. In the current issue of *Electronic Products,* November 1966, Mel Mandel, Editorial Director, writes under this heading: "Readers favor CPS over Hertz two to one." The editorial is interesting in its one page entirety, and I quote this segment:

"When so many company presidents, vice presidents for engineering, general managers, chief engineers (and two physicists with the National Bureau of Standards) vote (three to one) against Hertz, it is obvious that our representatives to the International Electrotechnical Commission, where Hertz was selected, did not properly understand the people they represent. Should we use a little more democracy in selecting our international technical negotiators?"

It is not my purpose in this reference to imply a personal position but rather to re-emphasize that management is becoming more and more critical of the standardization function and of the standardizers. The consensus principle is going to require more surveillance. The consensus in the future must be consistently real and contain an "engineered component" of smaller size.

I consider it an exceptional honor to have been invited here today to participate in these historic dedication ceremonies and to mingle with so many fine people from so many great countries. As they have in the past, these great laboratories in their new, enlarged, and modernized setting are destined to continue as a tower of increasing strength in support of our United States of America standards program, nationally and internationally.

Dr. Astin: Our final speaker is Mr. C. H. Sharpston, who is the Secretary-General of the International Organization for Standardization (ISO).

Mr. Sharpston: Thank you, Dr. Astin. I wish to touch rapidly on three matters in the time at my disposal. The first is the general way in which the work of ISO is carried out; secondly, some Government legislation; thirdly, the interaction of standardization work at three levels—national, multinational regional group, worldwide.

International Organization for Standardization

The impact of ISO and IEC activities on world trade is greater than would be indicated by a recital of the nearly 1,000 Recommendations which have been published and almost as many Draft Recommendations now in the pipeline. This is a consequence of the way in which the work is organized.

In choosing its delegation to participate in our Technical Committees and Subcommittees, each national standards institute calls on experts from private industry, (as consumers as well as manufacturers), by virtue of the relationship which links the Institute to industrial companies and manufacturers' associations. It can and does include, when appropriate, representatives of research laboratories, Government Departments, consumers' associations, and so forth. The composition of a national delegation is altered where necessary from meeting to meeting, in the light of the agenda.

In the give-and-take of international negotiation within the Technical Committees, delegates obtain first-hand experience of the way world trade can be hampered by the absence of international standards, and likewise of the difficulties in achieving such standards. They carry this experience back into their normal professional work as well as contributing their practical wisdom to the international recommendations for standardization.

In the last analysis, the scale of our activities in ISO and IEC, and our effectiveness, depends upon the national Member Bodies. It was they who constituted our organizations originally, it is they who finance our work, and exercise control of policy.

My colleague, Louis Ruppert, the General Secretary of IEC, is here with us, and he can speak more particularly about his organization. As far as ISO is concerned, national Member Bodies fully agree with Mr. Wynn that we have not grown recently as fast as our responsibilities. They have recognized this in the most practical fashion, by voting funds for 1967 which are more than double those of 1966.

A greatly strengthened staff will not only enable us to process more Recommendations, doubling and then redoubling the output of recent years within 24 months; it will also make possible a more skillful coordination of the work of our many Technical Committees and a more sensitive planning of our forward program to match the needs of world trade.

Some 20 years of experience bear witness to the fundamental soundness of our organizational structure, to its flexibility and its adaptability. If Mr. McCune is right, we might have to be 10 times as active by the early 1970's as we are today, I don't know. What I do know is that, provided industry and governments agree and make the resources available, ISO will measure up to that challenge.

Incidentally, Mr. Wynn mentioned that the Soviet Union and other countries of Eastern Europe do not hold the secretariats of many of our Technical Committees. That is true, but whatever the historical reasons for this state of affairs, it does not represent today a lack of confidence in the value of ISO's work. It is no secret in fact, that these countries desire to take on more such secretariats as the opportunities present themselves.

There is a solid foundation of international recommendations in the basic fields of terminology, units, symbols, methods of measurement, documentation, classification, etc. This work is continuing. In the field of applied standards, the record is admittedly more patchy. It does, however, include many Recommendations relating to physical, mechanical and chemical methods of test; methods of sampling and quality control; safety standards; product quality and "fitness for purpose." My list is not exhaustive.

As one of the means whereby technology is diffused from industrially advanced countries to developing countries, the work of our Technical Committees and the resultant ISO Recommendations play an important role. The developing countries participate in this work to the extent of their capabilities —and as consumers where they may not be producers. We also have begun to hold seminars and con-

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Mr. Sharpston's industrial experience was with the English Electric Company and more recently with a member company of the Joseph Lucas group. His work has encompassed market research, sales forecasting, export projects and budgeting. He has dealt extensively with overseas negotiations relating particularly to the European Economic Community. He has spent the past few years as Director and General Manager of two subsidiary companies of Joseph Lucas (Industries) Ltd. in Brazil.

Mr. Sharpston received his education at St. Paul's School, London, and at Corpus Christi College, Cambridge, where he obtained a first in mathematics and economics.

ferences to guide the newly developing countries in standardization matters.

Government Legislation

Next I want to take compulsory standards, where safety, health, and public amenity are involved. At the national level, government departments will generally draw heavily on outside advice about the technical content of legislation in this field. Add the extra dimension of a world community of trading nations and you need to think a bit more carefully—how to organize the preparation of such legislation, in order to achieve an organic international whole. The commonest approach is to move on from established national legislation to inter-Governmental negotiation aimed at reconciling the national differences.

The greater the technical content of such legislation, the more I would question the efficiency of this procedure. It seems to me that an alternative approach should be adopted more frequently. This is, to begin by ironing out the national differences in the purely *technical* aspects, within the non-Governmental forum of ISO and IEC. The component of expertise in public administration can be introduced at this stage quite effectively by having government officials as advisers to or members of national delegations in our Technical Committees.

When the draft Recommendation emerges from a Technical Committee, we have a period for the fullest consultation of all interested parties, prior to submitting it to our Council for approval. In the class of standards which I am discussing, governments *as such* would be the most interested parties. By the time ISO published a Recommendation, Governments could nearly be ready with draft legislation to submit to individual legislatures. I am aware that this kind of legislation is by no means non-political and non-controversial. That is the case however, whichever approach is adopted. I wonder how many of you agree with my ideas.

Coordination of Standardization at Various Levels

Thirdly, there is the issue of standardization at national, regional, and international levels, and the best way to coordinate them. There can often be a basic dilemma. The smaller regional groups are more cohesive, and likely to be more active and work more quickly than a worldwide organization. On the other hand, fully international standards benefit these groups most in the long run, and a set of discordant regional standards may actually make it harder to agree subsequently on an international standard.

In parallel with the work in Western Europe described by Mr. Wynn, the harmonization of standards in Eastern Europe is undertaken within COMECON and in the Americas by COPANT—the Commision Panamericana de Normas Tecnicas. There is no simple solution, for we must recognize that the pressures for action at the regional level are often stronger than at the international level. In most cases at the regional and the international level, we are seeking to iron out differences between national standards which already exist. I can only suggest a complete flow of information from the various regional groups to ISO. If we see that the work is moving towards a consensus in a given sector, well and good; if it seems to be moving on a collision course, we could discreetly drop some words in the appropriate ears.

The great challenge, however, lies in the newer technologies and the new developments within older technologies—the challenge, to write truly international standards from the start, *instead* of several national standards. I would contend that the best hope of success in these cases is to go clear-sightedly and with firm purpose for negotiation at the international level only.

Dr. Astin: Thank you very much, Mr. Sharpston. I am sure that there are a lot of questions remaining but I will have to ask you to refer your questions to these gentlemen at the reception this evening. I would like to thank all of you for participating, and most particularly to thank the speakers for their most interesting contributions.

Banquet Program

Chairman: Mr. John T. Connor, Secretary of Commerce

Secretary Connor: In this nation, beginning around 1950, a few people outside of those directly engaged in the work began to realize the significance and the implication of the progress being made in the field of science and technology. At about the same time, a few others began to realize the great importance of international trade, and began to talk about the importance of growth in international trade, and the absolute necessity for broadening the area of free trade on a fair and reciprocal basis.

Still fewer people in this country combined those interests and those understandings and articulated them in the context of the subject of this symposium: the effects of technology on international trade. One such individual—and an exceptional one—is here with us this evening. He is Vice President of the United States. May I present him to you now: The Vice President.

HUBERT HORATIO HUMPHREY, *Democrat, of Waverly, Minnesota, was born in Wallace, South Dakota, on May 27, 1911. Mr. Humphrey received a degree from the Denver College of Pharmacy in 1933, his B.A. degree from the University of Minnesota in 1939, and his M.A. from Louisiana State University in 1940.*

He was elected Mayor of Minneapolis in 1945 and 1947. In 1948 he was elected to the U. S. Senate and re-elected in 1954 and 1960. His Democratic colleagues in the U. S. Senate selected him as the Assistant Majority Leader in 1961. In 1964 he was elected Vice President for the term beginning January 20, 1965.

He is President of the U. S. Senate, a member of the Cabinet and National Security Council, Chairman of the National Aeronautics and Space Council, Chairman of the Peace Corps Advisory Council, Chairman, National Council on Marine Resources and Engineering Development, Honorary Chairman of the National Advisory Council to the Office of Economic Opportunity, Chairman of the Special Cabinet Task Force on Travel USA, member of the Board of Regents of the Smithsonian Institution, and Chairman of the Cabinet Task Force on Youth Opportunity. At the request of the President, the Vice President has helped coordinate and implement the Federal government's responsibilities in the areas of civil rights and poverty.

Speaker: The Vice President of The United States, Honorable Hubert H. Humphrey

Address: Technology and Human Betterment

Vice-President Humphrey: Thank you, Mr. Secretary, you have an imposing list of participants in this conference. By the time it is done, I am sure that just about every conceivable aspect of technology and trade . . . technology and competition . . . technology and investment . . . technology and growth will have been examined and discussed.

I am also aware that the so-called "technological gap" between the United States and other nations—particularly our Western European friends—can hardly be escaped these days. Each day there seems to be a new proposal—and some of them have been good ones—toward closing that gap. If there is a technological gap, there is no gap in the information about it. Therefore, rather than enter into any technical discussion this evening, I would simply like to leave behind a few general observations and ideas.

First, although some people deny it, I do not dispute the fact of a technological gap. I know that all the statistics indicate that we in the United States have commanding leads over Western European nations in many fields—especially in computer technology and utilization.

But we have advanced technology in large part simply because our industry, which exists in many cases on a far larger scale than European industry, has had the need for it. Supply *does* follow demand.

Proposals for Closing Gaps

I think by far the most promising proposals for closing the American-European technological gap have been those such as Prime Minister Wilson's on Monday for a European Technological Community. If Europe—which has already seen the benefits of a European Economic Community, a Coal and Steel Community, and an Atomic Energy Community—were to pool her technology in a similar way, I have no doubt that the gap would already be a long way toward being closed.

The very fact of entry into the European Communities by Britain and her EFTA partners—and eventually perhaps by others—would help create an even larger European market and larger industry able to finance and sustain advanced technology, along with the necessary research and development. And from the general need for such technology, I feel sure it would follow.

The Rich-Poor Nation Gap

This leads me to my second observation: Namely, that economic integration and the creation of larger, continental markets—all over the world—can be a powerful force for closing any technology gaps.

It seems obvious, but too often overlooked, that small and poor nations stand little chance for economic sustenance if they do not seek economic integration—or at least, close economic cooperation—with their neighbors. This is beginning to happen in Latin America, Asia and Africa, but not nearly rapidly enough.

I am pleased to see that "Technology and the Developing Countries" will be one of your subjects tomorrow.

Long after any North Atlantic technology gap is closed, it will be the business of the Atlantic nations to try to close the far more dangerous rich-poor nation gap. We in the rich nations must begin taking more active steps now to help the poorer nations build their economies, create broader markets, and develop their own technologies.

I do not mean that each developing nation, and its economic partners, will need the capacity to produce and market sophisticated IBM systems. I do mean that, without trained manpower and the ability to enter the technological age, the developing nations will not only be unable to compete in world markets but that the resulting political and social unrest in these nations will be a threat both to their own security and ours.

The Proper Ways to Use Technology

And this leads me to my third general observation: That we all ought to do a little more thinking about what technology is *for*. If technology is used just to construct more impressive pieces of hardware—without resulting human benefit—then it will be wasted.

I believe that today we have the technological capacity already at hand: To rebuild the decaying central cores of large cities all over the world; to provide decent and reasonable housing on a wide scale; to lift primitive agriculture into the modern day; to compress the time scale for nations with catching up to do; to master our physical environment before it masters us; to end the coexistence of starvation and abundance on the same planet.

In my view, the real "technological gap" is between our technological capacity and our application of it to social needs. These needs—such as education, public health, recreation and transportation—exist in every part of the world. Meeting these group needs, however, is quite different from meeting individual needs such as for automobiles, clothing, or electrical appliances.

Old ways of doing things simply won't do the job. We need new mechanisms, new ways and means for bringing technology into the market place of public needs.

Constructive New Partnerships

Here in our country the model may lie in the constructive partnership of government, industry, labor, and the university that has been so successful in our space program. The talent and resources of all these elements in American society brought to bear in an efficient and coordinated fashion, have moved us forward in space far more rapidly than we would have hoped even a few years ago.

We have seen, too, what government research and development contracts—given to the university and to private corporations—have produced in overcoming scientific and technological obstacles in a remarkably short time.

The same partnership concept . . . the same "systems approach" . . . the same investment in research and development, applied to other public needs, may prove to be the way in which our rich nation may finally be able to overcome economic and social problems which have been generations in the making.

I believe, too, that private industry, acting on its own, can be a powerful force in overcoming these problems. In the United States, a good deal of our technological capacity lies in private industry. In other countries, this situation often differs.

I know from personal experience that American business today is demonstrating a social conscience. This has been shown again and again in such areas as equal employment opportunity, retraining of workers, and hiring the handicapped. Often as not, public service has also turned out to be profitable. I think that American private industry—operating in a competitive environment which promotes efficiency—can profitably enter other areas of public need, providing educational services, slum rehabilitation, and such things as information systems.

Where these things may not be profitable, I believe we in government should do what we can to be of help until they become so. (But I have the feeling many of these things can be profitable from the start.)

Today we are putting to use in government many of the modern management techniques already used in American industry. In formulating federal programs and in organizing ourselves—such as in the new Department of Housing and Urban Development, and of Transportation—we are increasingly concerned today with attacking our national problems with the highest degree of coordination and cost-effectiveness. We have for example, with the creation of the new Department, begun to consider transportation as the problem of how to move men and materials most effectively, rather than the particular problems of railways, airlines and highways.

The new Demonstration Cities Act, passed in the last Congress, is our first legislation which attempts to pull together *all* programs for the city—programs for economic opportunity, for housing, for clean air and water, for social welfare, for highway construction, for neighborhood renewal, and so on—and bring them to bear together in the right mix, in the right place, at the right time to best improve the urban environment. Up until now these programs have too often been administered without regard to their relation to each other, or to their order of priority.

And both the partnership concept and systems approach have been put to work in the war on poverty—part of which is managed under contract by private American corporations. In California my friend Governor Pat Brown—working with aerospace companies—has made a promising beginning at the state level in applying these approaches to problems of transportation, garbage disposal, crime, and paperwork.

We are just beginning to utilize our technological capacity for human benefit here in the United States. We are learning. But, during the learning process, we still—as the world's most technologically advanced society—have a responsibility to help create human benefits in other places by making our knowledge more widely shared.

How to Transfer Technology

Technology moves in the form of products and services that nations exchange. It moves through patent royalties and licensing arrangements. It also moves in textbooks.

I have noticed that while a breakthrough in science flashes quickly around the world, a breakthrough in technology may take years to find its way to a place of need. What we should seek, therefore, are rules and practices to help speed the flow of technology, not slow it down or stop it.

I know the argument that technology carefully gained should not be easily shared, lest hard-earned competitive advantage be lost. The argument against sharing of technology, it seems to me, is not unlike the argument against liberalized trade. But in technology, as in trade, the benefits of openness and free exchange would seem to outweigh any loss of temporary, protective advantage.

I should think that an *international* patent system, for instance, would go a long way toward safeguarding ownership of valuable technological processes without burying each nation under paper.

And it seems clear to me that the United States' own long-term economic interest dictates that our trading partners should develop strong, technologically based competitive economies.

Stemming the Brain Drain

Technology also moves in the minds of people who travel from one country to another. Some travel to teach, and some travel to learn.

When students have been trained in another country and then remain there to fashion their careers, we are faced with one element of what is the now-famous "brain drain."

There are thousands of young scientists and engineers working in the United States who came here to learn, but have stayed to earn.

If it is any comfort to those nations which have lost the services of their talented citizens, they should know that we have experienced a comparable situation in the United States. Some of our states and regions graduate more Ph.D.s each year than they employ. There is a "brain drain" from our Midwest to our East and West Coasts. We deplore this. But from a broad, national point of view, we can at least take some comfort from the fact that the United States as a whole is richer for this new talent.

There is no comfort at all for the developing country desperate for trained manpower when that manpower is swallowed up here. These are precious human resources they cannot afford to lose.

How do we reverse this flow?

First of all, I take it for granted that good, technically trained people do not turn away from their homelands for money alone, or for better living conditions alone. Any good man wants to be where the problems are and where he has a fair chance of solving them. He also wants to utilize the most modern equipment and facilities.

There are some things we can do. I believe a great part of the problem lies in the educational systems of the *industrialized* countries. Too often, we offer discipline-oriented—rather than problem-oriented—education and training. Quite properly we emphasize the "ics"—physics, optics, nucleonics. I believe we must emphasize, too, the "tions"—education, transportation, nutrition, communication, irrigation—the things needed in developing countries—so that both our own citizens and those of developing nations can acquire the useful skills of nation-building.

I think, too, that we can help draw these valuable people homeward by making available to their own nations equipment and facilities that they have become accustomed to here. Our government agencies, our universities, and private industry are all topheavy with equipment which is perfectly satisfactory for skilled use, but which has been superseded by the next-generation model. As chairman of the Aeronautics and Space Council, I have made it my particular business, for instance, to see that equipment which has served its purpose in our advance research and application in space has been put to good use elsewhere.

We can help by working with the developing countries to insure that too high a percentage of their students do not come to the United States to acquire skills which have no relation to the priorities at home. We can also, quite practically, do what we can to help establish institutions in their home countries which will give these young people the skills they need without leaving home in the first place.

Flexible Approaches

There is the across-the-board need to help build the technologies of the have-not nations so that their talented people will have sufficient daily challenge. It is clear that unemployed or underemployed scientists, even if they do not leave their country, pose political and social problems. In all we do to raise technological capabilities around the world, and to use those capabilities for human benefit, I am convinced that we should not become bound by doctrine, dogma, or ideology.

In the United States there were any number of people who argued that there was no way to undertake a major effort in space except under *complete* government auspices. Yet, as I have related, we have been successful with another approach. I am equally sure that the approach we took would be a dismal failure in many other countries, because of the varying strengths and relationships in their societies.

Opportunities for Business

We need to find out what works, and use it. I can think of a number of opportunities, not tried or barely tried.

For the business executives here tonight: I believe private corporations should think about establishment, with other corporations—regardless of their nationality—of joint training institutes in talent-short parts of the world.

I don't mean that you should establish your own private foreign aid programs (although I'd be in favor of that too). What I see are cooperative arrangements which meet the intellectual needs of the people being trained . . . which help meet the national goals of the country in which the institute is located . . . and the legitimate financial objectives of the private or public enterprise company which sponsors it.

Opportunities for Universities

To those of you from universities: I would like to see schools established by you, on your own initiative, devoted to city-building, to agricultural development, to modern management. Why can't we export the essence of the Harvard or Stanford Business Schools?

I believe that American and European universities—increasingly breaking out of isolation from their own societies—should try to meet as well the human needs of the people living in the forgotten two-thirds of the world.

Opportunities for Foundations

To those of you from private organizations and foundations: What opportunities do you see? Here in the United States we have a National Academy of Engineering. It took us a long while to get it, but now we have it.

I see no reason why the Academy could not serve as a clearinghouse in helping to set up similar engineering institutions in other countries, working on public problems.

Opportunities for Government

To those of us in government: I think each of us, in our respective governments, must seek new ways to use technology constructively.

The United States government, in this past year, has embarked on new international programs using technology in the fields of health, of education, and of agriculture. We mean to expand those programs. We have taken steps to remove barriers to the flow of scientific and technical information and instruments to and from our country. We have increased our programs of international exchange. But I have no doubt that we must do much more, as other governments must do much more.

I believe that we should be particularly receptive to proposals from other governments, from international organizations, from private companies or groups of companies, from any source, in fact, which wants to put technology to wider and better international use.

The least we can do is to reward initiative by others, and to remove unnecessary obstacles, when a good idea turns up. (And if the Americans in the audience have any doubt about where to submit their good ideas, I would refer them to Vice President Humphrey.)

The Need for Action

Finally, may I make this observation: We can perceive today the general need for . . . and the genuine benefit from the building of technological strength in every country of the world.

We can also begin to perceive the ways in which this can be done—a number of them have been discussed at this conference. What remains to be done is for all of us to *act* on our knowledge.

As Thomas Huxley once said: "The great end of life is not knowledge, but action." It seems to me an abysmal waste of time, of resources, and of energy whenever men build barriers between themselves or when they miss the opportunity to improve mankind's general lot on earth.

Today we have the chance—through technology—to remove those barriers, and to lift all our nations together by our action. *I think we should get on with it!*

November 17, 1966

Morning Session—The Impact of the Policies of Government on the Creation and Use of Technology for Economic Growth

Mr. Stern: This morning's session will deal with the instruments of government and how they may be used to encourage the creation and the utilization of technology. As co-chairman of the session and first to speak on the subject, we have with us the President's Special Assistant for Science and Technology, Dr. Donald F. Hornig.

Dr. Hornig: Ladies and gentlemen: It seems to me this symposium is unique in recent times in that it has brought together such a wide spectrum of people of different persuasions to discuss these topics.

The title of this morning's session is "The Impact of the Policies of Government on the Creation and Use of Technology for Economic Growth." I hope that our policies are more concise than that title. Government policies have at times been widely misrepresented, and discussed from many points of view. It seems to me that it is important that we get together for this kind of discussion.

We have with us this morning a distinguished group of panelists and discussants; businessmen, technologists and scientists. They are all a part of this problem, which I do not think is well understood. Nor do I think we have yet found, in our own government at least, all the proper mechanisms for taking into account technology as part of economic growth. I hope that many aspects of this problem will be aired and discussed this morning.

I regret not having been able to be with you to hear yesterday's fascinating discussion, and I hope you shall permit me to avail myself of the privileges of a Chairman to say a few words on his own behalf before getting discussion under way.

The Relation of Technology to Economic Growth

This general matter of economic growth, and the relation of technology to economic growth, has been one with which my office has been very much concerned, both domestically and internationally.

According to our Council of Economic Advisors, something over one half of total economic growth can be ascribed to the introduction of new technology. Although economic growth may not in itself be the end objective of a society, it is central to achieving most of the social goals and most of the material goals. The technological input is central to the progress of any country.

Broad Areas Involved in the Relationship

In thinking of what might be discussed this morning, I hope the discussion will cover the full range of the inputs that go into this problem, and not be narrowly focused. There are surely a number of ingredients of technological and industrial innovation with which governments must be concerned.

First, they must be concerned with the availability of suitably trained people, not only scientists and engineers but entrepreneurs, inventors and managers. Secondly, they must be concerned that resources for new technology are provided. This involves risk capital or business credit on proper terms, the availability of economic and financial information and the availability of scientific and technological knowledge to those who innovate. Also involved are such matters as the development of markets for advanced products—and such markets may be generated either by the existence of a taste for advanced products in the society as a whole, or more consciously by government procurement. There is the matter, particularly in a free enterprise economy like ours, of the creation of a climate for innovation in a variety of forms. And each of these are matters to which government policies can and should be addressed.

Further, the Federal Government has a central role—together with the states and communities—in connection with education. It isn't just the question of the mass education of people, but the *kind* of

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Dr. Hornig's early career included research at Woods Hole Oceanographic Institution and leadership of a project group at Los Alamos Laboratory. In 1946, he joined the faculty of Brown University, subsequently becoming Director of the Metcalf Research Laboratory. He later joined the faculty of Princeton University where he became Chairman of the Department of Chemistry in 1958 and first incumbent of the Donner Chair of Science.

A native of Milwaukee, Wis. (1920), Dr. Hornig received his B.Sc. and Ph.D. degrees in Chemistry from Harvard University. A Guggenheim grant and Fulbright scholarship for research at St. John's College, Oxford University, England, followed. Dr. Hornig was the first Bourke Overseas lecturer appointed by the Faraday Society. Some 80 of his papers in the field of physics and chemistry have appeared in professional journals.

education which is provided at all levels. The government is concerned with the problem of developing the basic knowledge and understanding which provides the raw material for innovation. In my own thinking I draw a rather sharp distinction between R&D per se and the innovative process. The two are closely related but aren't necessarily the same thing. The Federal Government now provides about 75 percent of the support for research in universities which is primarily concerned with the development of basic knowledge and the training of people. This makes the whole higher education process a major Federal responsibility. The Federal Government must be concerned not only with the conduct of basic research but with the health of the basic research establishment and, therefore, the health of the universities. There are many problems in carrying out this responsibility.

The Interacting Roles of Government and Private Enterprise

In our society, industrial innovation takes place primarily in the private sector. The primary role of the government, it seems to me, is to provide a climate for private initiative, and it does this through a wide variety of processes. Innovation is affected by a wide variety of governmental actions which aren't themselves technical or scientific. For example, there is no question but that in many industries the rate of innovation is very much affected by the nature of regulatory policies. Regulatory policies in the past have been thought of from the standpoint of their legal and economic consequences. I don't think there has been very much thinking about regulatory policies in terms of innovation. Additionally, tax policies may be critically important to industrial innovation. Tax policies can be restraints and brakes or can provide, as many countries have learned, incentives to innovation. The nature of anti-trust laws and regulations and the ways they are enforced are clearly important to the innovation process. It is important that we maintain an atmosphere and condition of healthy competition. On the other hand, care must be taken in some cases that the anti-trust laws not be used in such a way as to stifle innovation.

The purchasing policies of the U.S. Government, which spends one seventh of the GNP, are important in a variety of ways. In particular, the Department of Defense and NASA together buy probably $25 billion worth of highly technical products. Thus their purchasing policies can have a very important effect. I'm thinking, for instance, of such things as the nature of the contracts, how they are written, the use of incentive or fixed-price contracts, and so on. These all affect the mode of conduct under the contracts and the inducement to innovate.

Finally, there is the matter of new technology. This has been generated in great volume, primarily through the Department of Defense, the Atomic Energy Commission, and the Space Administration. I won't discuss this point further since it was so thoroughly covered last night. But it seems to me that U.S. Government support of new technologies has been effective because it hasn't just been an across-the-board support of technology *per se*. It has coupled the support of new technologies to urgent goals which had to be met. I think this has been an important feature of the governmental effort.

An analysis of the mix of all of the things that enter into the process of innovation has yet to be produced, or if it has been produced, I wish someone would call it to my attention. I hope that, during the course of the discussion this morning, some light will be thrown on many facets of this complex mix of factors, particularly in the context of a society in which the government and industry play complementary roles.

I think you know that the Department of Commerce, as its name implies, has a key role in these problems. However, the problems cut across all parts of our Government, so many of them can only be dealt with at the level of the White House.

The Need for Close Industry-Government Dialogue

Before turning this session over to our co-chairman and to the speakers, I want to say that progress in this direction—the development of wise governmental policies—requires a good and close dialogue between government and industry. One of my own hopes is that we will improve this dialogue and I hope to take some additional steps myself in that direction. This symposium is one of the most important steps I have seen recently in improving the dialogue and the conversation among the various parties concerned with the creation and use of technology for economic growth in all of our countries.

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Dr. Hornig: It is now my privilege to introduce the first of our speakers this morning, Mr. Robert Major, who is the Director of the Royal Norwegian Council for Scientific and Industrial Research.

Mr. Major: It is a pleasure and an honor to address this distinguished group on the important theme of the impact of the policies of government on the creation and use of technology for economic growth.

I will discuss this theme by trying to answer the following questions: In the first place, what are the main factors in building up national technological research potential? And second, what is the role of government in building up these potentials? That is, how can government stimulate the creation and use of technology for economic growth, and what do governments do about it? Third, what should we expect governments to do in this field in the future?

Building National Research Potential

Let us briefly look at the factors which build up the national research potential. There is a need for a system capable of educating in quantity and in quality all personnel needed for national research activities and for industry, and for other activities making use of research results. There is a need for fundamental research institutes in the universities, or as separate organizations to pursue the search for new knowledge, thereby also nurturing applied research activities and giving inspiration to higher education. There is a need for applied research institutes and laboratories which can assist in solving the practical problems which are faced by a government of our time, and which can also help in the development of production methods and of new products throughout industry. There is a need for a technical information system which brings an ever increasing knowledge from national or international research to the people needing it in the form and at the time they need it.

But all this is not enough. Knowledge acquired in educational systems is only useful for economic growth when the educated personnel learn how to use it in industrial activities. And research itself has no economic value until it has been built into new processes or new products. There is also need for dynamic industry which has the right structure and management open to the exploration of research itself, sufficient risk capital, and a market big enough for the product. Without such a dynamic industry, even first class research itself would have no bearing on the economic growth. It is further necessary to understand the interplay of all these factors and to create a natural climate for development of all these factors.

Government's role in this picture varies from country to country, depending on the degree of industrial development, on the national goals. I do, however, think it right to say that in all countries government's role is growing. This is partly due to the growth of research activities, but also due to the fact that it was not until lately that most governments have discovered the roles government could and should play.

Let us look at the situation in regard to different factors I just mentioned.

Planning the Educational Program

The most striking example of government growth in the fostering of education is perhaps the development of the educational system in Soviet Russia during the last decades, which was so well described in Nicholas de Witt's books. This is an example of how a government decision, under that particular regime, followed by long-term action, can change completely one of the conditions for economic growth in a nation.

In Western countries, education facilities have traditionally been developed through an interplay of initiative from private quarters, municipalities, states and the national government. We all remember what happened in this country after the first Sputnik in '57. A strong government policy mobilized the whole education system in a joint effort to expand education in quality and quantity, an effort which has had far reaching effects in this country.

The most striking recent work in this field in Western Europe has in my view taken place in the OECD. In cooperation with the Committee on Scientific Personnel, the Directorate of Scientific Affairs of OECD has built up a milieu which has made thorough studies of most of the relevant questions which have a bearing on the supply and demand and also use of scientific and technical personnel in many of the countries.

The OECD's work has very strongly influenced educational policies and planning in most European

ROBERT MAJOR *is Director of the Royal Norwegian Council for Scientific and Industrial Research, an organization which he has headed since its formation in 1946. Under his guidance, the Council has established a number of specialized research institutes, including the Norwegian Institute for Atomic Research which operated the Dutch-Norwegian Joint Establishment for Nuclear Energy Research in cooperation with its Dutch counterpart.*

As Norwegian representative to the OECD Science Committee, and earlier to the OEEC Committee for Productive and Applied Research, Mr. Major has represented Norway at numerous international meetings concerned with scientific and industrial research. In addition, he has served as a member of the Norwegian delegation to the first and second United Nations "Atoms-for-Peace" Conferences held in Geneva in 1955 and 1958.

A native of Oslo, Norway (1914) Mr. Major received his Master of Science Degree from Oslo University in 1941, then serving a period as Scientific Assistant there. He saw war service with the Norwegian High Command during the period 1941–1945, and was Secretary of the Committee for the Organization of Scientific and Industrial Research in 1945 and 1946.

countries, and I think also it has had something to say for work here. With the rapid growth and change in the demand for various types of personnel, and in view of the long time it takes from the decision to build an educational institution to the time when new candidates have been educated, the need for a national analysis of the comprehensive future requirement of personnel and the need for policy and planning by government, has now been understood and, I think, accepted in practically all the Western countries.

The rapid advancement of knowledge also demands a constant change of curricula and new teaching methods. This situation will demand, at a growing rate, a re-education of people working in all branches using science and technology. This will probably mean that very soon a considerable part of the population will have to use at least 25 percent of their time for re-training all through their working years. There is also in many countries the view that more should be done in the educational system to encourage the development of creativity.

The current explosion in education and the rapidly growing need for increased investment in education have made the role of government all the more important in all countries. Governments in Western countries discharge their responsibilities in the educational section by various means. Sometimes it is through the establishment and direct control of educational facilities; in other cases it may be by means of financial contributions distributed through proper channels or agencies to the educational establishment run by states, municipalities, or by private initiative.

This growing demand and rapid change throughout the educational field puts a rapidly growing strain on government resources and initiative. No country has yet reached anything like maximum development and use of its talents. I believe that much is yet to be achieved through an interplay of people in government, in the educational system, in industry and in other activities needing trained personnel.

Fundamental Research

Fundamental research is, I think, now recognized in most governmental circles as basic to the development of new technology, and as a factor of importance for economic growth. The results of fundamental research are on the whole common property, and it has therefore been recognized that governments must carry the main part of the financial responsibility for its pursuit. In spite of this economic dependence, there has been a general understanding for many years that decisions regarding how money for fundamental research should be spent should be left to the academic community.

During the last decade the pursuit of knowledge, particularly in the physics field, has as we know demanded ever more expensive installations, such as accelerators, radio telescopes, et cetera. We've got "big science," which now in most countries takes a growing part of the economic resources available for fundamental research.

In advanced countries, between ten and twenty percent of the overall R & D expenditure is now used for fundamental research. This corresponds to between .1 and .3 percent of the Gross National Product. The development of "big science" has, particularly in small countries, but increasingly in the medium sized and big countries, strained the financial resources for fundamental research. For the small country it is now impossible to take part in the forefront in all fields, and also for the medium sized countries it is becoming more and more difficult. This has created strong pressures for establishing criteria for the allocation of resources for fundamental research. And as governments are the main source of money this will of necessity force governments to take part in priority decisions.

I think so far too little thought has been devoted to the situation which becomes more and more critical. Especially for the small countries, some rethinking and adaptation to the new situation seems to be required. The general tendency is to try to copy the big countries' research pattern and take an active part in all fields. This will, to my mind, have to be replaced by more modest and realistic goals. There are still many fields of fundamental research offering great scientific challenges which can be pursued within a modest financial frame. In more expensive fields, there are possibilities for the establishment of cooperation with other nations.

I believe the time is right for government, specifically in smaller countries, in close cooperation with the representatives of their academic institutions, to study how fundamental research in the future can best be pursued for the benefit of the country within the financial resources which can be expected to be made available.

The Governmental Role in Applied Research and Development Work

Government's role in the field of applied research and development work falls mainly into three categories. First, in certain fields where government has its own activities such as defense, government will itself be responsible for the creation and use of the appropriate technology. Second, as government is interested in the over-all national economy, it must also feel a responsibility for stimulating the creation and use of technology all through industry, particularly in those industries which are not in a position to take the necessary steps themselves. Third, government is also responsible for development of a general national climate conducive to the creation and use of technology throughout society.

Fields of Government Influence

The technological fields where government is responsible for activities vary from country to country. In all countries it includes defense. In many countries it includes telecommunication systems, power supply, roads, railways, and also the search for and conservation of natural resources, environmental pollution, etc. In addition, of course, there are the more recent programs such as those concerned with space.

Governments usually apply two different measures for the creation and use of technology in these fields—the establishment of government research institutes, and the contracting of research and development programs to industry. The balance between these two tools varies strongly from country to country.

The establishment of government research institutes is the oldest method, and, particularly in countries without a heavy commitment in the defense field, it still seems to be the more important one. Many of these institutes have performed excellently. I think, however, it is a general experience in many countries that research doesn't always prosper in a rigid government system. In some countries there is a move to establish institutes of this type as semi-governmental institutions, thus giving them greater flexibility in their operations.

The contract system has been developed mainly in countries with heavy defense and space commitments. As you know, the United States now spends approximately eighty percent of government R & D funds for military and space purposes. About three quarters of this money is used for R & D contracts to industry. This represents more than fifty percent of all R & D activities performed by industry. This is a volume which is many times higher than the total of all European R & D contracts of this type. The impact of this on industries working for defense and space, mainly the aerospace industries, is immense and well known.

Influence of Military R & D on Civilian Economy

The spill-over effect for civilian industry is, as we know, difficult to ascertain and much debated. Everybody seems to agree that there is considerable and valuable transfer to civilian technology. However, they also agree that the transfer is not big enough, leaving to the responsible government circles the problem of increasing this transfer through the dissemination of reports, exchange of personnel, etc.

I believe that a good many of the people in this auditorium know more about this subject than I, and I shall therefore not go into detail, but I would like to mention that these types of R & D contracts are very rare in many countries where the defense activities are at a relatively low level and space activity hardly exists. As many industries in these countries have to compete in the world markets, it has become a problem for those nations to find ways and means whereby they can stimulate their industrial technology to make up for this deficit.

This leads me to the next point—how the government can stimulate creation and use of technology in fields where government has no administrative responsibilities. The old established method for this stimulation is the creation of government research institutes working in specific fields like agriculture, fisheries, raw materials research, and also the creation of institutes to establish national competence in fields of general interest to industry, such as weights and measures, standards, etc. We all know that there is a great variety of examples of the high value of activities in institutes of this character.

Research Associations and Sponsored Research Institutes

A more recent development, which has taken place mainly in Europe, is the establishment of research associations. As is known, these work on mutual problems for specific branches throughout industry. There are in Europe approximately four hundred of them.

The volume of work in these institutes in the individual European countries varies from a few percent up to ten percent of the R & D work performed by the industry as a whole. Most of the institutes have a government subsidy varying from zero up to sixty percent of the total income of the institutes.

A considerable portion of the activities of these organizations involve technical information activities. The main purpose of the Research program is to increase the quality of existing processes and to improve the quality of existing products. The programs are therefore usually unspectacular in nature and this type of laboratory has appeared to be useful mainly in old established industries. The over all usefulness of these institutions is debated. I think that on the whole this is because many of them are too small or have been established in industries which they are unsuited to serve.

Since the last war there have been established in many European countries sponsored research institutes of the Battelle Memorial type. They work mainly for research-based competitive industries. A good many of them receive financial support from governments to enable them to establish competence in fields that are considered to have a general national interest.

Method for Governmental Stimulation of R & D in Industry

Particularly in countries with few R & D contracts from defense, space and atomic energy, a need has, as mentioned, been felt to compensate for the absence of spill-over effect such as benefits civilian industries in the United States and some of the other countries. We can here on the whole distinguish among three different methods which have been taken by the government. First, the development of a procedure whereby government agencies procuring products of advanced technology are authorized to give R & D contracts to national companies to enable them to compete on a more favorable basis with the big international concerns. To administer such programs effectively, the government agency must build up a staff competent in long term planning, for the working out of specifications and for handling of R & D contracts. The administration of such programs also calls for the wise selection of fields in which to encourage the development of national industries.

Second, in many countries, companies which have valuable ideas for innovation are unable to finance innovation costs or to get loans through the usual credit institutions. To meet this situation, several governments have established so-called development funds, which function as a bank with risk capital, giving loans to cover up to fifty percent of the development cost of a project. When successful, the company will repay the loan with interest. When the project is unsuccessful the loan will be waived. Some organizations of this type also take an active part in the exploitation process, like the National Research Development Corporation in Great Britain, which can draw on a government credit of up to twenty-five million pounds. Others act like banks and leave the exploitation to the manufacturing company. Some of these new agencies seem to have had success with several of their projects but it is yet too early to judge their importance as a whole.

Third, in certain countries research councils or similar agencies, which usually spend their money in research institutes, have lately been allowed to spend money also in industries with the aim of building up national competence in new subject fields, such as systems engineering and the like. Because of the government financing, there is usually a requirement that the general results of these research projects be available to other firms in the country.

The above mentioned three procedures, R & D contracts from government agencies to industry as part of the buying procedure, the establishment of development funds, and the use of government money to build up technological competence in industry, are on the whole relatively recent developments.

The ideal situation for a country is of course, that industry is so strong and viable that this type of stimulation is unnecessary. The stimulus is felt to be needed partly because the financial resources of industrial units in many countries are too small to develop competence in new technological fields, and partly to compensate for the absence of the spill-over effect which prevails in other countries. There is, however, the danger that these measures can be used to conserve industries which would never be competitive, and they should therefore be used with great care and wisdom.

Judging from recent trends it is, however, likely that these activities will play an increasing role in government policies to create and use technology in the years to come.

The Need for Technical Information Centers

With the growing flow of technical information, it is a problem, specifically for smaller firms, to acquire all the information needed for their production. In most countries, governmental or semi-governmental organizations therefore have established information centers and advisory services of various kinds. There seems to be a general feeling in many countries that compared to the money and effort spent on research projects, the investment to make sure that existing knowledge is being effectively used in industry is much too low.

The Climate for Research

In addition to all these activities of a more concrete character that I have mentioned, governments can stimulate technology and its use through the creation of a general industrial climate conducive to research activities and the exploitation of research results. Activities of this kind include the development of taxation systems with the right financial incentives, suitable patent policies, and general endeavors to remove obstacles such as customs barriers, thereby creating bigger markets for the sale of industrial products. These indirect general measures can have a profound influence, but I understand that they will be covered later today and I will not go into detail. I will just mention them as a very important method in the hands of government to stimulate the creation and use of technology.

International Cooperation and Government Policy

One aspect of government policies for the creation of technology which will no doubt grow in importance is international cooperation. I think it correct to say that the greater part of international exchange and collaboration in the scientific and technological field, both among scientists and companies, has grown up without any government initiative and will continue to do so. But with the growing role of government in the national scene, government policy will also have a strong and growing influence on international activities. I can mention: government policy for declassification and dissemination of reports from government financed research; bi-lateral agreements between governments for research cooperation in fields that require big research investments, such as atomic energy, space, et cetera; and multilateral cooperation in general international organizations like the United Nations and OECD, and in international research organizations like the European Nuclear Physics Organization (CERN) in Geneva, or the European Space Organizations, ESRO and ELDO.

I think that not all of these international activities sponsored by governments operate quite efficiently, but they serve their useful purpose for exchange of information and make it possible for small and medium sized nations to take part in "big science" activity. I think, also, scientists usually find it easier to agree than politicians and I believe that the international atmosphere created by scientific cooperation can be an important factor for the stimulation of world trade.

The Technological Gap

I had intended here to discuss the so-called technological gap between the United States and Europe. After the Vice-President's speech last evening, I will, however, just say very briefly that it seems to me we often think wrongly with regard to this gap. To my mind, it is not so much a question of technology as of mentality and attitude. In your country here you have quite an eye for the future; you have a dynamic industry, and you have built up managerial skill and big markets. I think the difference in all these factors is very much more important to explain the gap than the difference in science and technology. We need a better diagnosis of the technological gap between Europe and America before we start to suggest remedies.

Overall Financial Resources for R & D

The growth of government activities in the research and development sector demands increasing financial resources. As you all know the total R & D effort in the industrialized OECD country varies from approximately one percent up to some three percent of the GNP. Now these expenditures can be divided into three categories: R & D expenditure for defense purposes, which varies in the different countries from 0.1% to 1.6% of the GNP; government R & D expenditure for civilian activities which doesn't vary much at all—it is approximately 0.5% or a little lower for all industrialized countries; and, third, research and development expenditures in the private sector, which varies from 0.3% to a little over one percent of the GNP.

Now, taken altogether, government financial contribution to the R & D effort varies from 0.5% to approximately two per cent of the GNP. In percentage of gross national R & D expenditure, government contribution makes up from thirty percent as in the Netherlands, up to more than sixty percent, as is the case in this country. All governments in the advanced countries now see the importance of these activities for the culture, for the economy, welfare, and security, and are spending an increasing share of national financial resources in this sector. But we may, of course, ask how wisely do they spend their money—what systems have they developed to evaluate the programs and what is their efficiency in all this work?

Efficiency of the Technological Effort

On the whole, I believe a historian some years hence who will write about science in the present-day society will find that the efficiency of the over-all system was then not too high, although it varies considerably from country to country. Most countries are still experimenting to find out how best to organize themselves to evaluate programs, to establish criteria and priorities. They also must choose the fields in which they wish to concentrate. This is particularly true of the smaller nations.

Some countries have established a ministry for science which is responsible for the broad policy decisions. Examples are France, Germany, and for a time, also, Great Britain.

Others find that research activities will have to be an integral part of practically all the different ministries' activities and find it difficult to concentrate the responsibilities in one ministry. Their solution is usually one or more national committees for science policy close to the president or prime minister, to give general advice. They leave administration of programs to the different ministries or established agencies. Examples here are in the United States, Belgium and the Scandinavian countries.

What seems essential in all systems is to develop enough people with a thorough and broad knowledge of how science works and how the results can be exploited in industry, people who can serve in government departments on advisory committees at different levels, and in semi-governmental and industrial research organizations. It is only through the interplay of such people that good proposals for government action can be worked out and wise decisions reached.

If we see government's role in the creation and use of technology in perspective, there has been a rapid growth both in direct responsibilities, in the allocation of money and in results obtained. It represents, all together, I think, an impressive impact. To my mind there is no reason to believe that this trend will change in the immediate future. This is a consequence of the growing complexity of life in society and also of the inherent nature of science and technology.

The growing reservoir of knowledge to be passed from one generation to another and the better education of a larger number of people needed for the type of occupation we can foresee in the future society, will increase the responsibilities in the education sector. The need for ever more comprehensive technological knowledge in all branches of industrial life, the growing complexity of each subject and the growing need for cooperation will increase the demand for government measures to stimulate technological development.

Government's Future Role

What sort of technology-based activities governments will administer in the future is more difficult to foresee. With China in the picture, it is most likely that defense activities will continue. Space research is most likely to continue, at least at its present scale, unless joint programs should be established with the Soviet Union, in which case a good deal of the national prestige and competition might disappear. Development of the fission process for the production of energy seems on the whole to be passing over to industry, but it is not unlikely that demand for increased government support for development of new sources of energy will be required in the future.

We have, I think, passed through an age of chemistry, we are in the age of physics, and I believe we are on our way into a biological age. This will open up new aspects and possibilities which may quite drastically change our way of life. We must expect that in the years to come we shall be thinking not so much of our standards of living, but of our standard of life. Much more emphasis will no doubt also be given to environmental research and the urban problems, transportation systems, et cetera, and in all these fields it seems likely that government will have to be heavily engaged.

I think that in most countries there is need for a much stronger harmonization of research activities with the over-all national goals. Too many small countries tend, in their research efforts, to copy research activities of bigger countries, forgetting about the high threshold value for realistic activities in a growing number of fields. Considering the immense effort put into the actual research work it will, to my mind—with these problems of size, priorities, selection and choice that most countries have to face—be necessary to devote greater efforts to the development of well-conceived and realistic science policies.

In many fields the best results will only be achieved when countries are brought together in cooperation in a more meaningful and cohesive pattern. Those countries which will be the most able to master all these problems will to my mind have a great advantage, both for economic growth and for life in society as a whole in the years to come.

Dr. Hollomon: To continue our discussion of the impact of policies of government, we bring to you a person who has long been engaged in industrial activity, and whose training is not in technology or science. He is especially interested in marketing. Recently, however, he has made two excursions into the government realm. In one of these, he is serving on a special panel that is advising the Secretary of Commerce on the climate for invention and innovation in our society.

A member of that panel said at one of its later meetings, "I'm not sure that we should ever tell anybody about the real result of our work because, you know, there's a great story and myth going around that all we have to do is to do lots of R&D, then to give R&D away and to help people to trade, and ultimately everything will work fine. Most of the world believes that. Our real secret in this country is the fact that a young fellow has a chance to go out and start a small new business on his own without having to work through established organizations or the conservative constituencies."

Some of the panel thought, good humoredly, that we ought to keep this report secret, because otherwise we might lose our competitive advantage. *We decided to make it public and take the risk!*

I would like to introduce to you Mr. Peter G. Peterson, the President of the Bell and Howell Company.

Mr. Peterson: I noticed that we had some Frenchmen in the audience and if they won't mind I'll tell a little story about the French acrobat, Blondeau, that I hope helps me make a point about the lead of the United States in technology.

As the story goes, Mr. Blondeau, the French acrobat, was crossing the Niagara and he was not only crossing it on a tightrope but he was carrying a man on his back. There were a million-and-a-half people watching this extraordinary feat of the Frenchman, including the President of the United States, the Prince of Wales and so forth. About a quarter of the way across, the man who was on the back of the Frenchman looked down at him and said, "Don't you think that we should reconsider? Don't you think that we should perhaps go back?" At which point—roughly translated to suit my purposes here today—Blondeau was reported to have said, "Just because you're on top doesn't mean you know where you're going."

So we need to remind ourselves of that.

Let me talk briefly about the panel that Dr. Hollomon talked about. We spent eighteen months studying innovation.* The chairman of our committee was Dr. Robert Charpie of Union Carbide. The panel membership consisted of prominent men in business, education and the professions.

R&D and Innovation

One of our early conclusions was that there had been so much emphasis and so much impressive data on how much this country spends on *research* and *development* that we wondered if there hadn't been too much emphasis placed on that. So, early in our study, we decided to make the distinction between invention and innovation.

I want to make the important distinction that we did between invention, which is to conceive—it's the idea—and innovation, which is the using, the process by which the invention gets translated into a product and brought into the market place. And if we're really interested in growth and the things that affect the quality of people's lives, we emphasize over and over again in our report that we really had to concern ourselves with *innovation,* not just research and development.

I'll make a perfectly obvious point now to those of you who are sophisticated in business. We noticed in our study that many people in government, and to a certain extent in universities, tend to think that innovation and R&D are the same phenomena, and if you just have more research and development, in some simplistic way—almost automatically—you get more innovation.

So in our report we presented some distribution of costs—as shown in Chart 1.

We simply put together the experiences of our panel members to make a point that we thought needed making: that the businessman looks at the

* The full report of the Panel, *Technological Innovation: Its Environment and Management,* is available from the Government Printing Office, Washington, D. C. 20402

innovation process as a *totality,* as a *total* venture, not just as an R&D expenditure.

And that in many, many projects the research and development, the idea stage, is really a small part of the total investment. In the case studies we looked at it was only about five to ten percent of the total process. We said to ourselves, therefore, if you're seriously interested in innovation you really can't pretend that the only incentives you need to offer—the only counsel you need to offer—is on how to invent, how to conduct R&D.

Why Should the Government have an Interest in Innovation?

We then went into the area of why should the government be interested in innovation. I won't bore you with the familiar statistics of how important innovation is, that it accounts for half or more of the growth of our Gross National Product, eighty-five or ninety percent of the increase in real output.

We decided that we ought to make this point a little more vividly. We chose three technological industries—television, jet travel, and digital computers—that virtually did not exist in 1945, and found that by 1965 they had contributed more than thirteen billion dollars to our Gross National Product and something approaching a million jobs (Chart 2). In addition, these three innovations obviously affected our lives in a very important way.

Another thing we did, in order to make vivid the point of how important technology is in terms of our economy, was to take five companies in this country that one could refer to as being *technologically innovative* companies, and see the thrust of these companies, which were by and large rather small companies or nonexistent in 1945. We can see in Chart 3 that these companies had an annual sales growth of nearly seventeen percent, whereas during the same period of time the Gross National Product of this country grew at a rate of two-and-a-half percent.

Next, we asked, what is the impact of innovation on international trade? You all have seen the data on the balance of payments, and of course we included that in our study, but we also included some specific examples to make the point that a gross number, like what happens to our total balance of payments, often obscures the fact that the real factor that underlies this growth has been in *high-technology* products.

For example, in the textile industry we chose cotton, wool and synthetic fabrics. If you study the data over only a ten-year period from 1956 to 1965, you will see that cotton and wool exports declined roughly a third whereas the exports of our high-technology synthetics went up from a hundred and fifty-eight million to two hundred and forty-one million (Chart 4). Thus, had it not been for the high technology product, I think it's pretty clear that our textile exports would have actually decreased. So, we had a section of our report that dealt with why innovation is important in practical, meaningful dollar and cents growth terms.

Innovation and Competition

As you've sensed, our country is also enormously interested in competition as well, and we wanted to make the point that we didn't think was made as often as it should, with regard to what *technology* has done to *competition.* This point concerns a comparison of the traditional forms of competition versus what we call the "new" competition, represented by the high-technology businesses. In the traditional forms involving largely non-technological businesses, this is often largely *price* competition between fairly similar products. But when you look at the new competition, the high-technology competition, you usually see entirely new categories of products that perform old functions much better or entirely new functions. Obvious examples in this country: xerography, synthetic wash-and-wear fabrics, instant photography. And these new competitors have—believe me, because we have "enjoyed" the "stimulation" in one or two of our businesses—enjoyed the astringent effect of this kind of competition.

There is another aspect of the new competition versus the old. Traditionally, in the nontechnological businesses in this country, we've had *familiar* competitors long-established. There's a tendency to get to know each other well, a tendency to have discussions, and there have even been a few occasions in which there has been a kind of collusion, whether conscious or unconscious.

But when you look at the new competition you often see competitors who are unfamiliar. They're called "outsiders" usually. Let's look again at some of them. We need only to remind ourselves that synthetic fabrics were not invented or developed by the textile business but rather by the chemical industry. Or, look at *high-speed ground transportation.* We might have expected all of this to come from railroads or automobiles, yet aerospace and electrical manufacturers have played a major role here.

PETER G. PETERSON *began his business career in 1948 with Market Facts, Inc., a Chicago firm specializing in marketing counsel and research on consumer and indnstrial goods. He was elected executive vice president in 1952. In 1953 he joined McCann-Erickson, Inc., advertising agency, as director of marketing services. He became a vice president in 1954, general manager of the Chicago office in 1956, and a director in 1957.*

He joined Bell & Howell Company in April, 1958. As executive vice president he headed the company's Photo Products Division as well as Bell & Howell's corporate market planning and prodnct development programs. He also served as chairman of the corporate research board.

In April of 1961, at the age of 34, he was elected president of Bell & Howell Company. His responsibilities were further broadened in July, 1963, when the board of directors named him chief executive officer of the corporation.

Mr. Peterson is a graduate of Northwestern University and the University of Chicago Graduate School of Business.

Instant pictures were not developed by the photographic industry or a company that had been thought of as being part of the photographic industry. Xerography was created and developed by a company that was outside of what we called the business equipment business.

Some Characteristics of Innovation in America

Now rather than just look at the total gross dollars on R&D, we decided that it would be interesting and perhaps fun to try and understand the *variation in* the expenditures in research and development. We looked at *four* kinds of variations.

First, public or social investment versus private sector investment. I wish we had the time to discuss this subject at this meeting, but it's clear that certain very important problems facing this country are not getting much R&D investment, and it's also very clear that the private enterprise mechanism, because of the great uncertainty and the great risk, is probably not the right kind of mechanism to get appropriate R&D investment in this area.

But within the industrial complex we noticed something else when we studied the output of innovation, from *one region* or *city* of America to the other, in one industry versus another, and for small versus large companies. Let me briefly take you through some of the findings, and I must say that this is not highly statistical data but, rather, personal experience of the panel members.

One of the things that becomes very clear in America is that you can take eight or ten cities in this country and look at the data on R&D investment, on numbers of scientists, on numbers of engineers, and then apply common sense tests on numbers of new businesses, numbers of technologically based new enterprises that are being formed, and you will often find a *substantial difference* between one area and the next that does not seem to have much to do with how much money is spent on research and development.

In America, for example, there are several areas, Boston, Palo Alto, Washington, Pittsburgh, in which you will see the spawning, the nurturing, the conception of many of these important small new businesses, some of which we might hope would be the Texas Instruments, Xeroxes, and the Polaroids of 1985.

But in other cities—my own city of Chicago, or Philadelphia—in spite of substantial R&D investments we do not see many of these new kinds of technological businesses being spawned.

We were also impressed with the obvious fact that there are tremendous differences in R&D investments by *industry* in this country, with steel, for example, spending about one-tenth of what the drug business spends in this country—shown in Chart 5.

Now to be sure, part of this is inherent in what kind of business it is. Quite frankly, gentlemen, we come to the conclusion that only part of it is due to what kind of industry it is. When you get behind some of these numbers and look at some of these industries, you're led to believe, at least, that the problem often is that the top managements of some of these industries have not yet learned to manage technology, and that in a curious sense this is perhaps an important reason why they are not spending as much money on innovation. And this is also the reason, we suspect, that some of these same industries are not innovation industries. So, a lot of it has to do with skill and managing technology and attitudes toward technology, not the inherent economics of the business itself.

We look at the variation in R&D by size of company in Chart 6, and the point here is that the small businesses—those with less than a thousand employees, which account for a very large percentage of the companies—account only for a very small percentage of the R&D done in this country. It is estimated that some three hundred companies in America account for something over ninety percent of the research and development.

We tied this particular finding in with something else. We looked at several studies that we could find on innovation in the United States. There has been one rather classic study, by a group of men who went back and studied the origin of the most important *commercial innovations* of the twentieth century. Now keep in mind that this is in the era, to a certain extent at least, that we have thought of as the era of the large company R&D laboratory.

When you look at these inventive contributions—as shown in Chart 7, you see outstanding examples of enormously important commercial innovations in this country—Xerography by inventor Chester Carlson, the vacuum tube by an individual, the cyclotron by an individual, automatic transmissions by a small-company individual, the Polaroid camera, obviously by a small company individual. The point being that there is some impressive evidence that the small inventor, the individual inventor, the small businessman, contribute to the innovative flow in this country, at least, to a substantially larger extent than the amount of money he is spending on research and development.

Then we look at five other studies of innovation in the United States and they make the same point, that small businesses are responsible for an important portion of the significant inventions and significantly larger percentages than their small investment in R&D would suggest.

At this point our study then went down two tracks. I don't want to sound here as though I feel that large companies are dispensable in this process. They have a unique and a vital contribution to make.

On the other hand, we did decide that, given this kind of input on how important small companies were, if we were really going to study the innovative process in America we'd better break down the process into large companies and small companies.

The Innovative Process in the Large Company Environment

First, let us consider the large company in America, and the kind of growth problem it faces. In America we have all sorts of clubs with varying degrees of exclusivity. One of the more important clubs is the Billion Dollar Club. And we've decided to look at the Billion Dollar Club's growth problem the way it does (Chart 8). It has annual sales of a billion dollars. It wants to grow at least ten percent a year. Some of its old products decline about five percent a year. There is some price erosion due to competition and technological competition. If it wants to grow 10 percent a year, it must make up the seventy million it loses from price erosion and industry decay, plus another hundred million or so from new businesses and new products. So this company has to find a hundred and seventy million dollars a year of growth if it's to meet its objectives.

Now, what we've done in our report is to try to categorize the problems that this company has—as shown in Chart 9. They're really different problems —not just in degree, but in kind—from the small company's.

We see here this whole early stage of business planning very much concerned with words we're using more and more in this country—venture analysis, directional planning, strategical planning, business objectives. In short, where do we want the business to go?

There are some problems here. Problems like, "It wasn't invented here." A friend of mine thought that N.I.H. stood only for the National Institutes of Health. I told him that in this country a far larger membership was the membership of the "not invented here" club. A big company has the problem of understanding that important inventions in the company will not come always from the inside, as this study has demonstrated.

The new idea then goes through a second stage, the important stage of experimental appraisal. Here big companies are often missing entrepreneurial skills. I have talked to the heads of many large companies about this and when I asked them what their problems were they said quite often, "We are missing entrepreneurs; we are missing the men who can create businesses that have never existed before."

Then, very often, innovation within the large company moves into what we call the embryo stage, where one sets up small businesses and tries them out. A very delicate problem the big company has, as we have discovered at least in this country, is that if we take these embryo businesses and put them in *existing operating* groups or existing divisions they often get crushed or ignored. One of the problems a large business faces is how to organize for these new businesses. The big company has tremendous advantages in terms of skill and resources, production, engineering, money, plant facilities, market research, et cetera, et cetera. However, when it gets into this stage, we in this country run into anti-trust difficulties from time to time.

The Innovative Process in the Small Company Environment

Let us look at the small company—as shown in Chart 10, because it has a really different problem. This generally starts out with an idea, and the idea is usually a technical idea and it's usually an idea by a rugged individualist who has very little business experience but who has a total commitment to the fact that his idea is going to revolutionize the world.

Our economy is filled, incidentally, with examples of men like this who created businesses where, had they existed in the large company, their idea would never have succeeded because our various planning and analytical techniques might have crushed the vitality of their ideas. And I think we all recognize the enormous contribution they make.

When I say the words "total commitment," I'm reminded of a story. In America at least, it's a very old one—perhaps our foreign visitors haven't heard it—about the pig and the chicken who were walking by the restaurant and they see ham and eggs advertised. The chicken suggests they go in, the pig says no, no, no. He says for you it's a donation, but for me it's a total commitment. As we've interviewed these small companies, there's no question but there's total commitment in every sense of the word.

Now the kind of problems they run into when they seek money are the problems of how they explain to a hard-headed businessman or a financial person an idea that is very vague at best, and usually highly technical. One of the problems, which we will talk more about later, is that in the financial community there are very few men who are as comfortable with masers and lasers and quasers, and so forth, as they are with convertible debentures. Therefore, they have the important problem of finding people who can understand what they are talking about.

If they get this initial venture money—and it's very high risk money because many of these businesses fail—they then can go into the garage operation. We are talking here about a small business, less than five million, usually fifty to a hundred employees. They do not have a serious marketing problem because they often know most of their customers intimately. Often the government is supporting this kind of activity. It's usually custom manufacturing, it's really not high volume manufacturing.

But as they move from this stage now into the second stage where it gets to be a good size business and where there's more than five hundred people and where you can no longer know your customers, except in an impersonal sense, the problem starts shifting. And many of these small companies who are dealing with innovation start having serious problems in this particular stage. Why? They don't have experience in control technique. They don't know how to get a product from a custom manufacturing stage into a high-volume manufacture, and all that this requires in terms of processes and drawings, et cetera.

Financial controls, they haven't had to worry about before. Marketing, they really haven't had to worry about. So in this stage a very critical stage is reached where management, or lack of management, often becomes the decisive factor as to whether this business is going to become a Texas Instruments or whether it's going to remain a small business. If they can get out into this stage they have other problems. In this country we, of course, get into all sorts of questions which we review in our report. These deal with mergers and "escaping" and making your money, as well as anti-trust problems.

Some Findings and Some Proposals for Improving the Environment

Our panel had many recommendations and I'm just going to review a few of them. I would like to say that while we looked at tax incentives in this country, we could not convince ourselves that *major tax incentives* were really the way to foster innovation. The most frequently mentioned proposal of all is that instead of a fifty percent tax deduction on research and development we have a *seventy-five percent tax* deduction or tax credit, depending on how you look at it.

To give you an idea of numbers, this would cost the government, in terms of lost revenue, about a *billion and a half dollars* a year. And because over ninety percent of the research and development in this country is performed by large companies, most of this money would go to large companies. As we looked at the enormous demands for federal revenues, we decided that from a cost-benefit standpoint, to use a popular word, it was a little difficult for us to justify this kind of tax loss.

So we had a set of proposals that largely dealt with the small companies, because we felt the *leverage per dollar* was higher there. For example, if you *equalize* the tax treatment of profits and losses of large and small technically oriented companies, the life cycle of the small company is such that often they are losing money for at least five years. If you happen to be a company like duPont or General Motors or Union Carbide or Bell & Howell or Xerox or a company of this sort, you obviously take your innovation losses and write them off immediately. These, i.e., the small technically oriented companies, companies not only cannot write them off immediately but because of the five-year-loss carry-forward, they often lose the carry-forward. So we had a provision here that did something about this by suggesting that for these categories of companies the tax loss carry-forward, at the very least, be extended to *ten* years.

We had other kinds of provisions. I emphasize to you that if these companies are going to become big companies they need to attract *management,* which often they don't have. How do they attract management that is skilled in high volume marketing and manufacturing? Obviously, they attract it from the large companies.

In 1964, in this country, there were major revisions of our stock-option arrangement, as some of you know (Chart 11). The purchase price of the stock went from eighty-five percent of market value up to a hundred. The period of option exercise went from ten years to five years. The life cycle of these companies, of course, makes this a difficult but very important problem, because the stock of these small companies is normally not nearly as liquid or convertible as is that of the larger company. Also in 1964, the holding time was extended from six months to three years. We've convinced ourselves, at least, that if we really want to help these small companies, we should go back to a more liberal stock option plan for these categories of companies.

Another specific proposal had to do with capital gains treatment to professional inventors. We have laws in this country that say, in effect, unless the inventor sells all of his patent he will not get capital-gains treatment for it. But this presents a serious problem. Many of you in this room are in business and you know that if an inventor walks in with what may be a promising idea, there are, at its early stages many questions, many ambiguities, many uncertainties about whether the idea is worth pursuing. From the standpoint of the inventor, if he has to sell it all in order to get this capital gain treatment, obviously, many of these transactions don't get made; many of the inventions do not get put into the flow in the market place.

So we had some suggestions about that. But I think the real point of our findings had nothing to do really with specific tax proposals. Our over-all findings really had to do with the fact that in this country, at least, we have made great progress in certain segments of technology; but by and large *there's not sufficient understanding* at government, university, business and banking levels of this fundamentally new process.

Many of our recommendations dealt with the education-attitude-communication side. For example, at the Federal Government level, we pointed out that there's really no federal spokesman—nobody that's concerned with the generation of new technological business. For example, we have the "Small Business Administration." By statute it can't possibly deal effectively with high-risk capital requirements of these technological firms. As we interviewed people in various departments of the government, we did not really find an understanding of the unique problems that these small technological businesses had.

As another study of a governmental problem in our country, we decided it would be interesting to write down all the government agencies that are responsible for policies that involve competition (Chart 12). As the panel studied this, it became very clear that there were a number of government regulatory policies that, when one really analyzed them, were anti-innovative, anti-competitive, in terms of their effect.

What are some of the reasons for this? Well, one of the reasons for this, quite bluntly and frankly, is that many of our regulatory and anti-trust agencies in this country tend to be staffed by legally oriented people, not by people who understand economic forces and, particularly, technologieal forces. Among a number of recommendations that we made in this area one was to seriously look at the possibility of putting men in our various bureaus and departments and agencies who have a genuine feel, a genuine appreciation, of *technology* and the *innovative thrust* in this country.

The Environment for Innovation

In some ways our most important conclusion has to do with how we get these ideas in small businesses *into the market place*. Why is it that Boston, for example, spawns so many of these businesses? Let me now tell you of a little study that was made of Philadelphia versus Boston, in which interviews were made of companies of this new type that had been founded there recently. For example, thirteen company founders were interviewed—seven in Philadelphia and six in Boston.

One of the questions asked was the role that local universities played in stimulating them to form a business. Obviously this is not a large sample; but in Philadelphia, of seven such firms interviewed, seven said the university played a small role. In Boston where six were interviewed—and keep in mind that Boston has many more of this kind of firms than Philadelphia—all six indicated that the university played an important role. You know, of course, that M.I.T. is one of the important universities that plays a role in Boston.

What about banks? They were asked, "What role did the local banks have with regard to helping you to get your business started?" Once again in Philadelphia (and, incidentally, I think the figures in Chicago would be very similar to these) seven out of seven people, i.e., the entrepreneurs, who founded the business, said the attitude of the banks was poor or bad. But in Boston, five out of five said it was good or excellent.

We became so intrigued with this phenomenon that I took about fifteen of our own executives in our company to Boston to try to understand this environment that is apparently much more favorable and stimulating to technological businesses. In the banking community in Boston you will find at least two major venture capital firms who specialize in getting *technology businesses* started. There are no such firms in Chicago and many other cities. In Boston we interviewed leading banks who had set up departments to deal with the unique problems of high technology business. You don't normally find these in other cities.

So what we have tried to do is to define this environment that seems to spawn and nurture and create these businesses. One aspect of the environment that is terribly important is banks or venture capital sources, who are at home with technically oriented businesses, who make it their job to understand what these fellows are talking about, who have business appraisal capabilities to diagnose the risks and who know whom to call in a certain field if they have uncertainty about it.

Another is the presence of technically oriented universities who are genuinely sympathetic and firmly believe that helping these businesses get started is an important contribution they have to make. I suspect that many of our universities feel that it is not an appropriate role for a university to really engage in an activity that's this closely related to commerce. I can only indicate to you that in Boston, at least, it's a dynamic force that has helped Boston recover from what could have been a disastrous loss following the removal of the textile and leather businesses from the Boston area.

A third aspect of the environment is the entrepreneur and we said in our report that entrepreneurship breeds entrepreneurship. Put yourself in this situation. You're a young man who has an idea, you're committed to it and you're trying to find out whether to start a business with this idea. I submit to you that if there are a few multi-millionaires in the community that have been successful in doing this, you're not going to be discouraged by that fact. And it's important to have these successful men.

In the environment we see people whom we call marriage brokers, who know how to find people for these small companies. How to get them management. How to help them get money at the right time if that's what they need. And, very important, communication. In the Boston area for example—this is also true of a few other areas—it is clear that there's a lot of talk back and forth between universities, banks, marriage brokers, small companies et cetera. We don't find this in many other communities in the country.

What have we concluded about innovation in terms of the government's role? Perhaps its most important role is to assume the leadership in getting this environment set up in the business community and in the local communities where bankers, businessmen, universities, technologists, et cetera, are working together to get these businesses formed. One of our important recommendations is to have a top conference in Washington, and then set up regional conferences in every major city of the United States, to get this innovation mechanism going.

Some Thoughts About the Future Environment for Innovation

What does this mean to businessmen? In the first place, we've had the model in this country that there are big companies and little companies, and the big companies get at the technology of the little companies by swallowing them up or acquiring them. I'm not so sure that's the only model, and I would guess—from my study of these small companies—we're going to see some *new creative* relationships emerge over the next five to ten years—creative relationships which will maintain the enthusiasm and independence of these small companies and yet add to them the skills and resources of the large companies.

I suspect our anti-trust people will have to do some serious rethinking about the conglomerate enterprise concept that they have found offensive. It could be argued that combinations of these small companies might be one of the best things that could happen to this country if we're seriously concerned with innovation and getting it started.

What I've really been talking about is a revolution that has been taking place in the world since the time primitive man first invented that wheel. I have a little story here that I hope makes a point. It is set in the primitive era, and features the sales manager of several hundred thousand years ago.

The sales manager says, "Oonka"—he's talking to his market researcher—"We've been getting complaints about our heavy goods transporter."

Oonka, who is the market research man, as usual is very well prepared and has his statistics in fine order. He says, "I can tell you exactly why. 48.3% think that the runners are too bumpy and lumpy and 39.2% say that the tow-rope keeps breaking."

"Well, that's simple enough," says the sales manager. "We're going to put research and development to work and what they're going to do is to develop smoother runners and stronger tow ropes."

The market researcher reflects awhile and he says, "Gee, that's all well and good, but what if, for instance, R&D came up with something spectacular, like a wheel?"

The sales manager looks incredulous and says, "What's a wheel?"

Oonka says, "I don't know, the word just came to me."

This apocryphal story is designed to make a point. In some circles in this country, at least, we have believed too seriously some of the literature about the marketing concept, in which, translated literally, somebody goes out and finds out what people want and the research people are instructed to carry out certain assignments. The real need these days is to have businessmen and men of affairs who are what I call bilingual; who speak the language of the market place on the one hand and the laboratory on the other.

A study was done recently of the six hundred senior officers of America's largest corporations: nearly forty percent had technical degrees. A study of the pool of executives from which the next generation's senior executives are going to come, men between thirty-five and forty-five, over half have technical degrees. One of the adjustments we must make in American management, and I suspect all over the world, is to get managers who have this bilingual quality. Because if we're illiterate as far as technology is concerned, we're going to be functional illiterates of a rather serious kind. I say this with real feeling. Incidentally, Dr. Hollomon was quite kind in not telling you that I spent about a year-and-a-half at M.I.T. One of the reasons it wasn't longer was that I have the unique distinction of having made the lowest mechanical perception score in the history of the school.

So, I say this with deep feeling, the need is for men who can understand what is going on in the laboratory. In one of the businesses that we are involved in, photography, we see an example of this type of person—that person is Dr. Edwin Land of Polaroid. This is a man who combines imaginatively what is technically possible with what is commercially feasible. He works at the frontier of science and yet he has a feeling of what people want. One of his great successes recently is a little camera called "The Swinger," and he's the kind of man who can say, "What we now need is a $19.95 Polaroid camera with a name that swings." We can't build a concept around a man like Dr. Land, but this kind of bilingual communication, if you will, has to take place.

Many of you, I know, are technical people, and one way of putting it is that we need an impedance match between the laboratory and market place, because too many of the signals, frankly, are getting lost and I think that if you talk to many, many senior executives in America, they're not concerned so much with the *amount* they're spending on research and development as they are with its *productivity* and what they're getting out of it. And they're concerned with the lack of an impedance match, the loss of signals.

It is my feeling that the creation of these new businesses that we've been talking about is not only essential to the problem of growth in a technological society, but it's one of the most torturous, exciting, difficult jobs that American industry faces and we just can't settle for having less than the best men devote themselves to what I've been talking about.

Many of us, I'm afraid, get to be prisoners of our environment. Marshall McLuhan was here yesterday. You know he talks about how we don't see the environment we're in. The comment he made that I think best captures this notion is, "I don't know who discovered water but I'm sure it wasn't a fish." The point, of course, being that we can't have men that are isolated from the rest of the world.

We often talk about the ivory tower and it has occurred to me that many of us in business and in government can become so isolated in our occupation and in our own technologies that we live in an ivory tower that is far more remote than the ivory tower of the academic person. And part of the shift that we're going to need if we're really going to make use of this R&D is to have businessmen, if I can use the phrase, who cross-pollinate. Businessmen who cross-pollinate with the non-suburban community, the academic community, the young community but, increasingly, the scientific community. And here I suspect, gentlemen, time is our enemy. Most of us—at least my day is like this—spend so much of our working day on monumental trivialities which bear only the dimmest relationship to what we're really paid to do, that by the time we extricate ourselves and get down to the business at hand, we're commonly too tired to cross-pollinate with anyone.

I will end where I began. We are on a tightrope in this technological age, and we are walking on the tightrope across the exciting technological Niagara. The real question before the house is, "Can we stay on top and know where we're going?" We must. We can, and I think we will!

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CHART 1

TYPICAL DISTRIBUTION OF COSTS IN SUCCESSFUL PRODUCT INNOVATIONS

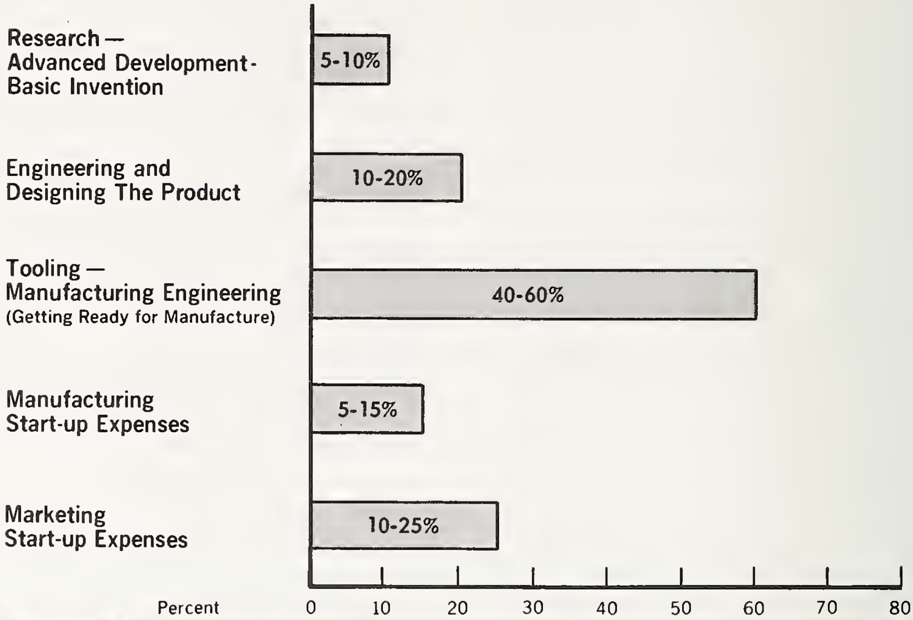


CHART 2

ECONOMIC EFFECTS OF ONLY THREE TECHNOLOGICAL INDUSTRIES OUT OF MANY

In 1945, the TELEVISION, JET TRAVEL, and DIGITAL COMPUTER industries were commercially non-existent.

In 1965, these industries contributed more than $ 13 BILLION to our GNP and an estimated 900,000 jobs . . . and very important, affected the QUALITY of our lives.

CHART 3

A FEW EXAMPLES OF TECHNOLOGICALLY INNOVATIVE COMPANIES THAT HAVE EXPERIENCED MUCH OF THEIR GROWTH IN THE LAST 20 YEARS (1945-1965)

AVG. % ANNUAL GROWTH (Compounded)

	Net Sales	Jobs
Polaroid	13.4%	7.5%
3M	14.9%	7.8%
IBM	17.5%	12.1%
Xerox (Haloid Co.)	22.5%	17.8%
Texas Instruments (1947-1965)	28.9%	10.0%

Average % annual sales growth of above companies*: 16.8%

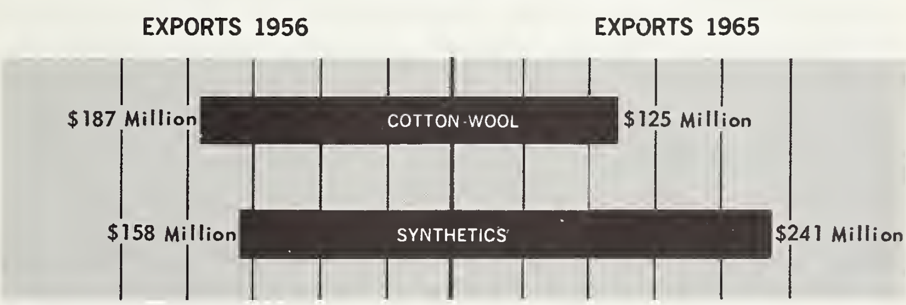
Average % annual growth of GNP: 2.5%

*Excluding Texas Instruments for which data are available only for the past 18 years.

CHART 4

INNOVATION AND INTERNATIONAL TRADE

An Example: U.S. Exports of Yarns & Fabrics
Synthetics (High Technology)
Cotton & Wool (Low Technology)



Source: U.S. Department of Commerce.

CHART 5

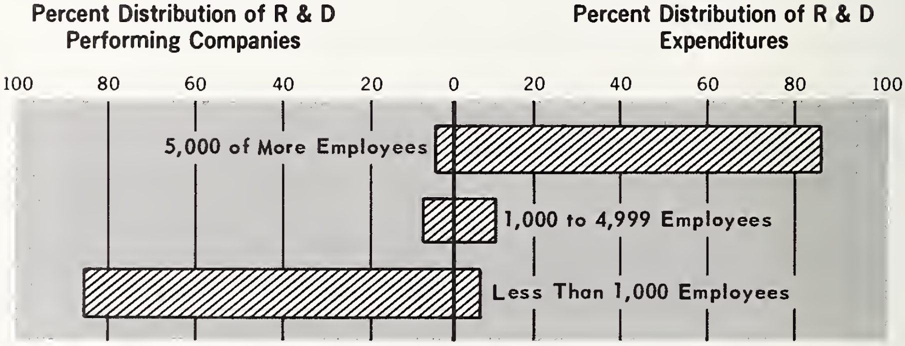
VARIATIONS IN COMPANY-FINANCED R & D AS A PER CENT OF NET SALES, BY INDUSTRY

	Net Sales (Billions)	R & D (Billions)	R & D Net Sales
Steel (Primary ferrous products)	17.8	0.111	0.6%
Transportation Equipment (Excluding aircraft)	34.3	0.865	2.5%
Chemicals	25.6	0.830	3.2%
Drugs	5.03	0.224	4.5%

Source: NSF (1966) — Figures are for 1964.

CHART 6

VARIATIONS IN R & D, BY SIZE OF COMPANY



Source: Basic research, applied research, and development in industry, 1962, NSF 65-18, 1965.

CHART 7

SOME IMPORTANT INVENTIVE CONTRIBUTIONS OF INDEPENDENT INVENTORS AND SMALL ORGANIZATIONS IN THE TWENTIETH CENTURY

Xerography
Chester Carlson

DDT
J. R. Geigy & Co.

Insulin
Frederick Banting

Vacuum Tube
Lee De Forest

Rockets
Robert Goddard

Streptomycin
Selman Waksman

Penicillin
Alexander Fleming

Titanium
W. J. Kroll

Shell Molding
Johannes Croning

Cyclotron
Ernest O. Lawrence

Cotton Picker
John & Mack Rust

Shrink-proof Knitted Wear
Richard Walton

Dacron Polyester Fiber "Terylene"
J. R. Whinfield/J. T. Dickson

Catalytic Cracking of Petroleum
Eugene Houdry

Zipper
Whitcomb Judson/Gideon Sundback

Automatic Transmissions
H. F. Hobbs

Gyrocompass
A. Kaempfe/E. A. Sperry/S. G. Brown

Jet Engine
Frank Whittle/Hans Von Ohain

Frequency Modulation Radio
Edwin Armstrong

Self-Winding Wristwatch
John Harwood

Continuous Hot-Strip Rolling of Steel
John B. Tytus

Helicopter
Juan De La Cierva/Heinrich Focke/
Igor Sikorsky

Mercury Dry Cell
Samuel Ruben

Power Steering
Francis Davis

Kodachrome
L. Mannes & L. Godowsky Jr.

Air Conditioning
Willis Carrier

Polaroid Camera
Edwin Land

Heterodyne Radio
Reginald Fessenden

Ball-Point Pen
Ladislao & Georg Biro

Cellophane
Jacques Brandenberger

Tungsten Carbide
Karl Schroeter

Bakelite
Leo Baekeland

Oxygen Steelmaking Process
C. V. Schwarz/J. Miles/
R. Durrer

CHART 8

GROWTH PROBLEM IN A SUCCESSFUL LARGE COMPANY

(Hypothetical Case)

Annual Sales	$1,000,000,000	
Sales Decline (Oldest Products)	5% Per Year	$70,000,000
Price Erosion	2% Per Year	
Typical Market Penetration	25%	
Growth Target	10% Per Year	$100,000,000
		$170,000,000

Such a company needs $170,000,000 of new sales from a combination of
(a) established products
(b) new products in established businesses
(c) new businesses

Ultimately this company must seek to enter completely new businesses or abandon its growth objective

CHART 9

MANAGING TECHNOLOGICAL INNOVATION

LARGE COMPANY ENVIRONMENT

	CHARACTERISTICS	PROBLEMS
BUSINESS PLANNING	Venture analysis Directional planning Business objectives control	Not invented here Time value of money Inbreeding Lack of specific market experience often kills good projects
EXPERIMENTAL APPRAISAL	Complex enterprise Has R/D organization May lack certain technical skills	Entrepreneurs missing Know-it-alls Risk vs. Cost emphasized Extend present businesses
EMBRYO BUSINESS	Outside inputs needed Incentives available Continuing R&D effort	Failure to meet return on investment criteria in early years Antitrust Key management
SUCCESSFUL GROWTH BUSINESS	Growth Jobs Products	Assimilation Antitrust

UNDERSTANDING (spans Business Planning and Experimental Appraisal)

CHART 10

MANAGING TECHNOLOGICAL INNOVATION

SMALL COMPANY ENVIRONMENT

	CHARACTERISTICS	PROBLEMS
IDEA	Individualists Technical Uncertainty No business experience Total commitment	Capital? In business?
MONEY	High risk requires high potential return Relatively small $ No technical experience	Appraisal Lack of understanding • Banks • Industry • Government • Universities
"GARAGE" OPERATIONS	Losing money Less than • 100 employees • $1 million capital • 5 years old Technology oriented High ratio technical men Government contracts Fast reaction time One or few customers Custom manufacture High return on investment High value added	Key management Incentives Fringe benefits Government procurement Total commitment
2nd STAGE BUSINESS	New kind of financing Dilution of equity Many impersonal customers Product oriented High volume manufacture More than • 100 employees • $1 million capital • 5 years old	Key functional staff Control techniques Market analysis World wide marketing Costs Competition
SUCCESSFUL GROWTH BUSINESS	Growth Jobs Products	Escape Merger Sell out Antitrust Timing

UNDERSTANDING (spans Idea, Money and "Garage" Operations)

CHART 11

SOME OF THE MAJOR 1964 REVISIONS OF STOCK OPTION PLANS ENTITLED TO CAPITAL GAINS TREATMENT

	Before 1964	After 1964
Minimum Purchase Price of Stock	85% of Market Value	100% of Market Value
Maximum Time to Exercise Option	10 Years	5 Years
Minimum Holding Time Between Purchase and Disposition of Stock	6 Months	3 Years

CHART 12

Dr. Hollomon: I'd like to introduce next, Professor James Brian Quinn of Dartmouth College for a discussion on these presentations. He has written much about the processes of research and development, their use and their management.

Professor Quinn: After the excellent statements by the Vice President last night, Dr. Hornig, and my two colleagues this morning, what should one add? I shall only touch on a few issues which I consider most important and highlight significant points already made.

There are some basic philosophical points which need emphasis in any discussion of government policy for technology.

The Nature of Technology

The most important of these is the nature of technology itself. Technology is knowledge . . . knowledge about physical relationships systematically applied to useful purposes. Its manifestation, hardware —which many consider technology—may or may not be technology. A crude lathe in the hands of a skilled man can represent a sophisticated technological system. But the most advanced computer in the hands of a savage jungle tribe is likely to simply be a rapidly rusting hunk of junk.

Thus when we talk of policies for technological development, we must think in terms of policies for essentially intellectual processes. This is something of a new concept for national policy makers and for all managers. The concept should include policies to stimulate both:

(1) The *creation* of knowledge for practical purposes, and

(2) The *use* and *transfer* of knowledge for practical purposes.

Within this context national policies for technology should include guidelines for the development, use, and dissemination of "management technologies" which—like operating research techniques —deal with optimal relationships between physical entities. Yet such technologies have rarely been discussed as a significant component of national technological policies. I believe this is a serious oversight.

To date, the European focus—and often that of the lesser developed countries—has been largely on how to *create new* technologies, preferably those based on frontier discoveries in the physical sciences. Mr. Major wisely did not limit his focus to this point. He recognized that the far larger question for Europe, the United States, and most of the world is how to intelligently *use* and *transfer* technological knowledge we already are capable of creating. In fact, for most of the underdeveloped and even developing countries, the foremost question should be how to *create* and *adapt* those relatively low-level technologies which could most easily relieve their people from needless unproductive routines and vastly multiply their real wealth, health, and capital formation potentialities.

With these philosophical views in mind, let us look at some of the more significant questions of government policy as they affect technological development. While I shall use the United States government apparatus as a focal point for my comments, the same general questions would exist for many nations.

The Public Interest vs. Economic Growth

At the heart of our discussion should be the question: How can the Government stimulate the creation, use, and transfer of technological knowledge in the "public interest," not just toward economic growth in the usual sense of an ever higher Gross National Product? Clean air, purified water, or higher levels of health may very well not mean as much economic growth as the use of similar resources in other ways. But such uses may be infinitely more important to the society than the implied loss in "economic growth." When we avoid the simplistic use of "economic growth" as the sole criterion for advance, this leads us to some most complex questions. What is the public interest? Who defines it? Should we consider a single cohesive "science policy" to support these goals, even if they can be defined? Or, should we really think only in terms of policies (plural) for science and technology?

Personally, I think, both. I feel that pluralism in approach offers great strengths for a technological society. The vying of individual minds and approaches—both within the government and in the private sector—to establish social goals and to solve society's problems, is among the greatest of all stimuli to the creation and use of technology.

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Professor Quinn's writing have been extensive, with emphasis on the planning, budgeting and control of research, and the transfer of the results of research to operations at both corporate and national levels.

But even pluralism can go too far. Some choices must be made by any responsible government in the interests of social efficiency and effectiveness. Government must avoid excess duplication of expensive programs. It must avoid undue conflicts in the purposes of related programs. It should avoid overemphasis on one technology at the expense of others which may be more important to the achievement of total social goals. It must choose where to invest when private investment mechanisms are inadequate for social purposes. Typically, as the primary supporter of a nation's R & D activities—and as purchaser of a large portion of a nation's Gross National Product—the government is a prime determinant of the *balance* toward which the society will direct its technological resources. Through its allocation mechanisms it establishes to a large extent which technologies will receive major emphasis, which will be stimulated to a lesser degree, which will be left to thrive under individual initiative and support, and which "big science" areas may be purposely ignored. For no single nation—not even the United States—can solve all the technological problems of mankind at once.

This hard fact leaves the U.S.—and all other advanced nations—with many difficult choices in policy. How much should the government spend in total on the development amd dissemination of technological knowledge as opposed to the private sector? How far can the government's decision making structure allow redundancy or competition? In what areas is it most important to set forth strict rules for action or general guidelines for choices? How can one hope to predict the ultimate impact of any given policy as its effects diffuse through the society? How can we even measure its effect after the fact in a complex social system?

Levels of Technology

Whether systematically or intuitively, governments must inevitably formulate policies for technological development. Whether they are formulated with a full sense of the complexity of a technological culture is another matter. Too often government policy for technology could better be called "policies for science and the advanced technologies." The effective "level of technology" in a society depends not just on its capacity to participate in certain advanced scientific areas—or even to "reduce-to-practice" first. Quite to the contrary, its true level of technology will depend to a much greater extent upon its ability to use relatively low degree technological knowledge in the routine production, distribution, and service industries, which are necessary to back up more advanced technological fields and which typically provide the bulk of its Gross National Product.*

The effects of many simple technologies, when multiplied through a whole society, may be significantly larger than the impact of a few more advanced technological capacities. For example, the prevalence of basic "work simplification" and "efficiency" concepts and attitudes everywhere in the United States may well be more important to its international competitive posture than even its most glamorous modern technologies. Thus, technological policy must consider not just the interests of science and the advanced technical areas, but the balance of technological knowledge which the whole society needs.

How can government policy stimulate the continuous development of both high and low level technological knowledge on a broad base in the society? More important for many countries, what policies can help induce good people to go into the less glamorous fields of technology—like highways, urban development, building trades, and so forth—where the ultimate payoff to the society may be much higher than investing the same skilled resources in advanced fields like nuclear power or computer technologies? These are problems which plague all the advanced western countries I have contacted in my international studies.

The Policy Formulation Process

How does a government exercise its role in national policy making for technological development? Here we should recognize clearly an often overlooked aspect of the policy-making process itself. National policy is rarely created finally by a "Sermon on the Mount" by a policy making executive. Even the excellent statements of the Vice President last night will not become policy until the apparatus of government acts on them in a consistent fashion. Government policy—as industry policy—derives from a complex interaction of many forces. These include, certainly, the statements of general guidance provided by top government officials. But they also include the recommendations and ego-involvements of people proposing programs and approaches at lower levels in government agencies. The project se-

* As a case in point; Communistic China has advanced nuclear and missile weapons capacities, but the limited availability of considerably lower levels of technology in her agriculture, transportation, distribution, and construction fields apparently constrains her per capita wealth to minimal levels.

lection and priority setting systems of each agency in essence formulate policy, as do the actions of inter-bureau budgetary and coordination groups (like the Bureau of the Budget or Office of Science and Technology in the United States) at the highest administrative levels of government. In many countries, the fiscal and political decisions of their legislatures are as important in policy formulation as the highly sophisticated analytical and organizational apparatus of their Administrative or Executive cadres. In fact, in the United States the Congress—through its fiscal controls and oversight activities—is perhaps the ultimate source of policy in many areas affecting science and technology. Yet its fragmented committee organization and review procedures practically insure non-cohesive policies in the government sector and an uncoordinated impact of government activities on the private sector. The complexity of the decision making apparatus in free countries thus militates against formulation of a truly integrated policy.

But even if all of these forces did interact to formulate a cohesive policy, there would still be the question of getting the government's far flung apparatus to follow that policy.

> For example: in the early stages of World War II, the central British Government bureaucracy may not have wished to emphasize radar research, but technical teams in the Government and the scientific community generally saw to it that the official policy was not followed. There are many other examples of similar failures in implementation. Some of these failures are healthy, some not.

Thus, as we talk of government policy formulation, we must think of the entire complex planning, evaluation, and control structure of the government and how it could conceive of and implement desired policies. It is ultimately this structure which allows decentralization in government, maintains pluralism in the government sector, and through its interactions determines the government's share of the "public interest"—yet does not imply omniscience or direction by any single group or individual.

Mechanisms to Exert Policy

In addition policies for the creation and utilization of technology in a non-totalitarian society result from an even broader-scale interaction among government activities and other social forces outside the direct pale of government. The primary role of government is to balance the impact of these forces, stimulating some and suppressing others in the public interest. It exerts its role as a balancer in a variety of ways, and policy questions are associated with each of the mechanisms through which the government typically directs its influence.

This morning Dr. Hornig touched upon several of the most important ways in which the government extends its role as a policy formulator into the private sphere. He mentioned the government's role as a *buyer of technology*. This role raises many important questions. How can the government insure a favorably balanced impact on the society from its many decentralized buying functions? How can consistent and beneficial priorities be set *within* mission-oriented departments, *between* mission-oriented departments, and for new social needs not presently or exclusively within the defined missions of existing government departments? How can government develop its functions as purchaser of items desired by the public—yet too complex or costly to be bought by individuals or localities—without infringing unduly upon the personal freedoms of its citizens?

Other questions exist concerning the government's role as an *investor in technological knowledge*. How can the government balance its commitments for future needs against current necessities? How can its complex political and policy apparatus evaluate the relative worth of investments in general education, science, social sciences, or the humanities against added technological development? No accepted criteria even exist for weighing such alternatives. Neither are there adequate data nor analytical techniques for evaluating such questions. Until such criteria, data, and techniques do exist there can be no realistic alternative to pluralistic competition for resources.

Still other questions result from the government's *regulatory role*. For example, how can government adequately estimate the impact of its economic, fiscal, and social policies on the development and utilization of technology in the national interest? How could the U.S. government have weighed the impact on its technological communities of its recent decisions on interest rates and the rescinding of depreciation credits against the other economic and social goals these policies sought? What role should government take in establishing physical standards for products and processes to obtain desirable consistency among local, regional, state, and private users? How can the government analyze and predict the impact of its rules, procedures, and practices—under contracts and in heavily regulated private sectors—on the technological capacities of those sectors? How can it obtain productive comparability among regulations in competing or impinging sectors without imposing bureaucratic rigidities which inhibit or prevent flexibility and change?

Thus, the central question of government technological policy is: How can a government achieve cohesiveness in the effects of its various policies on the total society without destroying the freedom and pluralism upon which the dynamism of that society often depends? But these are just the questions which exist at the *government level* in national policy formulation.

The Private Sector and National Policy Formulation

In a free society the government does *not* determine national policy alone. The decisions of private concerns and individuals are as important, if not more important, than government decisions in determining the overall posture of the nation. Thus, major questions exist concerning the relationship in a free society between public vs. private choice and development and utilization of technology by the public vs. private sector.

What role should the government play in the *creation* of new technology? Should it limit its support to education and the support of basic science? Should it support development programs for items to be sold in the private sector? Should it create cooperative laboratories for lagging sectors? To what extent should the government participate in the actual production of technological goods and services in the United States? What policies can be formulated to differentiate the roles of the public and private sectors? If there is to be a "new partnership" between industry, education, and government—as many have suggested—what should be the terms of this partnership? These are basic policy questions, and I submit that we have neither good data nor good theory on which to base conclusions. Consequently, perhaps our only approach can be experimental.

Further policy questions strongly affecting the private sector are these. What policies should government develop concerning the size of competing units within its borders? How can the economy benefit most from the production and marketing economies of scale offered by large size *and* the flexibility and freedom offered by smaller units? I feel that a country needs both giant and small companies for its continued healthy development. The question is how to develop policies which encourage rational development of both—and discriminate seriously against neither one form nor the other.

Another most significant policy question for the private (business) sector is this. How can private producers be stimulated to further develop markets where group consumption is essential? How can traditional business attitudes toward group consumption markets be changed? Can the benefits of private production be maintained when group consumption becomes essential? Since the problems of all societies indicate that group consumption for health, education, de-pollution, transportation, urban development, and so forth will be increasingly essential if man is to improve the quality of his life, how can private and government attitudes towards these markets be changed to develop the most effective relationship between private production and public consumption? A most important development (in the U.S. and many western European countries) over recent years has been the constructive participation by businessmen in government policy formulating commissions, such as: our recent National Commission on Technology, Automation, and Economic Progress; the Royal Commissions of Sweden; and the various planning committees in France. In all these countries there appears to be a changing attitude among businessmen toward "group consumption" as something apart from the dreaded "socialism" it was identified as in the past.

Labor's Role in National Policy

Another private institution—organized labor—also largely determines any free nation's technological posture. Labor can encourage or virtually stop technological change in specific sectors. To assist economic growth through technological advance, government policy must help develop flexibility of movement, job adaptability, and acceptance of technological change in the labor *sector*. The problem is how to accomplish this without infringing upon the freedom of laborers to choose their own futures and to work in favorable industrial relations environments.

There can be no question that technological development in the U.S. and Sweden (for example) has been vastly stimulated by these nations' high-wage levels and demand for excellent working conditions. How can such demands continue to be considered acceptable points for collective bargaining while the restriction of new technologies is severely limited? How can employment and unemployment practices be restructured to obtain a higher utilization and motivation of the employable work force? Along with others, I am deeply concerned that the administration of U.S. unemployment and welfare programs is often wasteful and can tend to impact unemployment, create unfortunate work attitudes, and increase social inertias—rather than relieving the problems they seek to solve. Yet the producing sector must shoulder the added burden of unnecessary social overheads. What new forms of data and incentives are needed to keep able people actively and flexibly producing for the society while the truly handicapped receive the care they need? Again neither an adequate theory nor reliable data exist upon which to base firm conclusions.

National Policy and International Affairs

A final set of policy questions exists particularly for the United States in relationship to international affairs. As the dominant technological power of the Western World, the United States runs a risk of becoming *emotionally* and *politically* cut off from the allies it needs throughout the world. Consequently, there is still another series of policy questions which our government must (almost uniquely) consider in relation to its international posture.

To what extent should the United States encourage or actually discourage the "brain drain" from foreign nations? Our policies to date have generally encouraged movements of key people from friendly nations to the United States. But there is some question as to whether these people could not contribute more to long term United States' and world interests by being stimulated to stay in their native countries. Certainly the United States cannot isolate those persons who wish to come to its shores to share the excitement of working with the most advanced thinkers in their fields and to use advanced equipment only available here. But to what extent should U.S. national policy encourage the sharing, exportation, or use of technology abroad rather than domestically? What kinds of technological transfers are most effective to underdeveloped, developing, and relatively mature economies? If these differ, can the nation have one set of policies for one group of nations and another for others?

Despite many statements that technology is a "world resource" just like scientific knowledge, there is a real question whether sharing technology freely would actually stimulate or retard world technological development. Unlike scientific knowledge, which is generally sought for its own sake, technology is developed for its practical worth in specific applications. To distribute this value freely is to deprive risk takers of some of the presumed benefits of their efforts. To what extent should a government force individuals who have developed technological knowledge through their private resources—or a public which has invested heavily to obtain such knowledge—to share benefits with others who have been unwilling or unable to make similar expenditures? The fundamental question is whether all societies would tend to lose the important intellectual output of many private (or privately supported) inventors, if they were forced to share their technological knowledge freely throughout the world?

Finally, there is an entirely new private force in world technological affairs, the giant international technologically-based companies. Many of these now have greater technological and production capacities than nations long considered sovereign in world affairs. There are major questions as to how the policies of parent and host countries should be adapted to maximize the world-wide effectiveness of these companies. To what extent can these companies be considered apolitical forces in the world affairs? To what extent are they to be regarded as logical extensions of their parent and/or host countries' national technological policies? What kinds of policies are desirable at the parent country level? At the host country level? At the special treaty level? International law level? How can all interested forces work together to obtain maximum international benefit from these new sophisticated entities which can contribute so much to or distort the cultures they operate within?

Conclusion

These are national policy questions which affect the development and use of U.S. and free world technologies. They are the dominant issues of our times and must be faced in the best way we can while we develop better data and techniques to improve our decision processes. But a key step in moving forward would be to recognize the complexity of the issues we face, the need for a thoroughly articulated science and technological policy apparatus throughout all elements of government, the critical relationships of the private business and labor sectors, and the new issues raised for all societies by the developing needs for group consumption and international exchange of technologies on a scale never before conceived. To solve these problems will require (1) new mechanisms of communication and cooperation among the three major sectors of labor, business, and government in each country, and (2) new concepts of how economic systems actually operate and the role of technology in world affairs.

Dr. Hollomon: Thank you Professor Quinn. I would like now to introduce to you Professor V. K. R. V. Rao, member of the Planning Commission of the Government of India, a person who has participated in United Nations affairs, and an economist who is deeply interested and responsible for finding ways of applying technology in an emerging economy.

Professor Rao: Mr. Chairman, I must begin by saying how very much I have enjoyed the educated discussions that I have heard both yesterday and today. I must also confess how deeply I have been impressed by the articulation of people who do not belong to the academic world. I find, for example, that the analysis presented by Mr. Peterson, who spoke a little bit earlier, is much more articulate than even that of the academic or the political world. I will take back with me these impressions, as an index of the skills that are fostered by the economic system in this country.

Just two or three points I wanted to make. I am expected to express views on policies of government toward the creation and use of technology. My country, India, provides a star example of how almost everything which has been suggested here in the course of the statements of these two days, can be tried.

Prominent Place of Science in Government of India

For example, I can recall that immediately after the country became independent, the Government of India, under the stimulus of Mr. Nehru, issued a special government policy resolution on science. The policy resolution indicated the importance of science and technology in economic development, gave the scientist a very important place in Indian society, created a scientific policy committee in the Cabinet, and so forth.

Then, definite steps were taken to foster scientific research in the public sector through the creation of laboratories of various kinds and of research stations in government departments. Our government's expenditures for research, I think, went up from 47 million in 1947 to something like 706 million rupees today, and we are still increasing our expenditures on scientific research. In our country, of course, these expenditures, unfortunately, are almost totally in and by the government; there is not any remotely comparable expenditure by private industry in my country.

Support for Education of Scientists and Engineers

Another thing is the question of adequate quantity and quality of scientific personnel. There again I think we started with about 90,000 persons entered in science courses. Today, the figure is 440,000 persons who are engaged in science courses in my country. By the time we come to 1970 and 1971 we will be under our Fourth Plan and we hope to reach a target of about 800,000 persons enrolled in science courses. It is not a very large number, because by that time the number of university students in my country will be between 2 and 4¼ million persons.

There is a great need for persons trained in engineering courses. We began with a national capacity of about 6000 engineering graduates per year. The number is now 50,000 and is expected to go up even more.

Developing Private Enterprise

Then, we, too, have a national resource in the private corporations that are trying to make salable and marketable inventions based on the findings in these scientific laboratories. We have something like 40 national science laboratories—some are basic research laboratories, and some are commodity laboratories. All my countrymen may not agree with me, but I think the latter kind is especially productive as far as development of commercial innovations are concerned.

Financial Encouragement

Because we have such a need to promote new enterprises, we have special depreciation allowances, we have development banks and special loan sources for making available funds to the private sector. As far as foreign capital is concerned, we welcome foreign capital. I think I can say with a sense of pride, mine is the one country where any foreigner is treated so that he may feel completely at home.

V. K. R. V. RAO *is a Member of the Planning Commission of the Government of India, with responsibilities for Agriculture, Education, International Trade, Social and Economic Research and Program Evaluation. In this position, he holds the rank of Minister. He is also Professor of Economics at the University of New Delhi, a post which he has occupied for twenty years. Professor Rao in addition serves the University as Vice Chancellor.*

Professor Rao founded the School of Economics at the University as well as the Institute for Economic Growth. He has also been active in the U.N. as Chairman of its Subcommittee on Economic Development from 1947 through 1950, and as a member of the U.N. Committee of Experts for Definition and Measurement of Standards of Living.

Professor Rao is a graduate of both the Universities of Bombay and Cambridge.

I don't think there is a single recorded example, in the last twenty years, of acts of hostility toward any foreign enterprise within my country. There is no discrimination and all tax incentives and fiscal incentives are available to foreign enterprises as well as our own. In spite of our being a democratic socialist country, we have no foreign investment controls. We are relaxed in our procedures; we are trying to stimulate growth by creating a favorable climate for foreign enterprises to come in.

How Have All the Policies Worked Out?

With all this attention, support and these resources, we have not succeeded in accelerating our economic development significantly. We have had some economic growth, and undoubtedly we are infinitely better off than we were twelve years ago. Nevertheless, we are nowhere near where we would like to be, nor has there been anything like a significant reduction of the gap between us and other major countries of the world. And, there are a lot of countries who have not been able to achieve this either. The failure is not trivial when it occurs in my country, India, numbering five hundred million people, and occupying a key position in the Asian continent quite apart from being an old and not entirely an uncivilized nation.

Now, what can we do? And this is a question which, if I may say so, we should discuss at length in a seminar such as this, but dealing specifically with the developing countries.

In trying to use technology and science for economic growth, I think it is important for us to realize that this cannot be treated as a matter of individual national policy. It cannot be handled only by each national government to meet its own problems, especially for those governments which find themselves occupying what is called a dominant world position. In some ways such governments are creating more problems for the developing countries, simply by the speed with which they are advancing their technologies relatively to the rest of the world.

NOTE: *The remainder of Professor Rao's text is paraphrased from his remarks, which, unfortunately, were not recorded* in toto.

I am not suggesting that they should stop advancing their technology, but every advance made in the developed countries does make it more difficult for the developing countries to catch up or reduce the gap that exists between them. I would like to take just a couple of minutes to propose some means for creating the conditions under which the developing countries can make use of technology for their own economic growth and for modifying their basic structure so that they may take their place among the growing and dynamic nations of the world.

We recognize that this will require a highly imaginative, as well as organized effort. A country like mine which represents a significant portion of the world's population approaches this era with the problem of surplus labor. Nearly 70% of our working population is engaged in manual or agricultural occupations. One cannot continue to have 70% of the population so occupied for an indefinite period if you want to establish the basis for economic growth and an opportunity to use technology to our national advantage.

Then we also suffer from a scarcity of capital. With the limited number of industrial operations, our capability to generate capital from earnings is severely limited. These two conditions reinforce one another to create serious barriers.

One of the fundamental requirements for utilization of science and technology in the underdeveloped countries is for the population to have functional literacy. Here again it is only a very small proportion of our population that is now able to read and write, which again limits the opportunities for economic growth and the contribution of science and technology.

What Remedies are Available:

There are some proposals I would like to offer for consideration with this audience. These suggestions may not all be able to be taken up concurrently, but I hope that, together, we can make some progress through applying ourselves to meeting the problems described earlier.

First, I would propose that we use the most up-to-date training methods to rapidly expand the proportion of our population that has functional literacy. Is it not conceivable that a massive program conducted during a period of six months to a year could increase significantly the proportion of our population which can use written instructional material? The increased capability of these trained people would begin to make our large population useful in the modern economic development process.

Second, I would propose the establishment of an international agency that would be concerned with the technological health of the developing countries. We already have analogies in the field of public health. We now need institutions that could provide the necessary technological constituents of a functioning economy. Such an agency would, on the basis of its experience throughout the world, be able to bring about conditions, throughout the developing world, that parallel conditions found satisfactory elsewhere.

Third, we need to find new means to make private foreign capital available to support the growth of export industries in the developing countries. Unless these countries can develop significant exports, it will be increasingly difficult for them to have the capital to purchase imports. It is, therefore, to everyone's interest that such export industries be built up and it may be wise to consider some proposals for sharing the export earnings between the countries furnishing the capital and the countries receiving it. In this way, the opportunities that exist for the developed countries in marketing to the underdeveloped world will have within them the seeds to make the developing world an active partner in future trade.

Fourth, The success of the U.S. Peace Corps in the field of cultural and social development provides a model that may be useful in the economic development area. Would it not be possible to establish a "Peace Corps" which might contribute effort and talent for the scientific and technological development of the developing countries. If our countries can develop independent positions in science and technology through such an injection of the wisdom and experience gained elsewhere, our countries will be able to make a more constructive contribution to world economic development.

Our over-all objectives should be, through the combined hard work of developing and developed countries, to create the conditions so that our large populations can become more significant producers and consumers of the world's goods and services. I trust that there will be additional consideration of the special problems of the developing world in symposia such as these. I would also encourage experimentation with some of these proposals in relation to the Indian economy which offers such an outstanding opportunity to demonstrate the feasibility of international cooperation in economic development.

QUESTIONS FROM THE FLOOR

Dr. Hollomon: As is usual with almost all affairs of men, schedules are difficult to keep; on the other hand, we have delayed lunch a little bit so we could have some more discussion between the audience and the panel. Do we now have questions, comments, suggestions, or controversy from the floor?

Question: I have a question, primarily addressed to our foreign guests, either Dr. Major or Professor Rao. We have heard a brilliant exposition by Mr. Peterson on some of the components of our technological environment. One is the tremendous influx of government money for contract research, and so on. Second is the large amount of private research and development wherein private companies support people in doing R&D and then to translate and convert it for commercial purposes. Third, we have the pluralism that Dr. Quinn mentioned, which is a many-sided way of encouraging entrepreneurs and enterprises to get started.

My question really is this: There has been a lot of pressure, because of the so-called technology gap with Europe, to emulate our government's R&D sponsorship. Do European countries really understand the other two components that have gone into our successful economy, namely the profit-oriented R&D, and the entrepreneurship? If they don't really understand that, then would not the adaptation of just one element, a large amount of government R&D money, give them a distorted technology that might accentuate the gap?

Dr. Hollomon: I think Mr. Major might want to react to that.

Mr. Major: The question is very rightly put and I think it is quite true that in Europe they do not understand this completely. Perhaps I could add now what I had in my manuscript on the technological gap that gives an answer in a way. It has been suggested that there be closer research cooperation in certain fields between U.S. and Europe as a way to remedy the gap. That is the Italian suggestion. Such a cooperation may be a good thing, but I doubt whether it would have the expected effect.

To my mind there is a gap, but I'm not certain that the reason the gap is there is to be found in the technological field. I believe that the fundamental reason for the gap is more a question of mentality and attitude. On this side of the Atlantic you are

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more dynamic, you see more in the future. In Europe we are, on the whole, more complacent. I think you have very often heard about the dollar incentive. Have you ever heard about a pound incentive? A franc incentive? Or a mark incentive? I never heard of it. Your attitudes have helped to establish the management skills, the big market, free of customs, and the big industrial units. In such a system it is obviously appropriate to make use of science and technology as important tools for the growth of the whole system.

Science and technology are and have been present in Europe for many years. What we'd like is the attitude necessary for the creation of more big industries with leaders who know how to make use of science and technology. We also need politicians, or rather statesmen, who can create the bigger markets which are needed for our companies to grow. I mention this because I think it is important for governments to consider the gap in full perspective.

Dr. Casimir: First of all, I am very strongly opposed to speaking about "the" technology gap—using the definite article. I think that is entirely wrong. I don't even like to speak about *a* technology gap or technology gaps.

What we have is a distribution of technological knowledge. In some cases the United States is ahead, and sometimes even far ahead, of Europe; in other cases they are slightly ahead. In a few cases Europe is ahead. Not even all of American technology is on one level—it shows a widespread distribution from the very advanced technology to primitive operations. To speak about all these distributions as being part of "the technology gap" is to create an artificial notion. It is getting into newspapers and it is getting into political discussions. I would like to abolish the words "technology gap" altogether, or if that can not be done, at least to abolish speaking about "the technology gap," because it does not exist as such.

Now, it is certainly true that there are symptoms that are alarming. They show that in the distribution of abilities there is considerable advantage to the United States in certain fields. Europeans don't welcome this trend. The question is whether people in Europe realize that this certainly is not due only to U.S. Government spending for R&D.

As you know, I have recently been around this country and interviewed people with a small OECD group. They will write a report on science policy practices in the United States. In our study, we tried to get more information on the influence of the government spending on research and development.

It is perhaps too early to formulate the conclusion, but still the general impression is that, although there is a positive influence there, it is much more indirect than many people in Europe believe. It is not so much the specific pieces of hardware and specific procedures that are turning out to be useful in the economic sphere, it is more a generally high-level of technology and a general managerial competence. It was already suggested here to us that if you want to speak about a gap, it is more of a managerial gap and an organization gap than actually a technology gap. As a matter of fact, if we bring people together in Europe in the right way, aimed at the right purpose, we can do quite well technologically, in many important cases.

Take the CERN organization at Geneva, dealing with high energy physics; it certainly can at this moment compete in results with high energy physics work anywhere in the world. The technology of the bubble chambers and their accelerator is quite as good as what you find here. It was all made in Europe by a combination of European firms. If the aims are clearly stated and the organization is well made, I don't think that technology is the difficult part.

Certainly there are fields where one has to rely on American help. One has to go to the United States for the big computers one needs. I don't consider that so very tragic. But there is one thing that one must never forget, and that is, that even when we train new managers and new entrepreneurs, the United States will remain a tough competitor.

What I should like to propose is this. If America really wants to do something about the "gap," start introducing a different currency in each of the fifty states, and impose other serious boundaries among all the states. You have enough Italians, Greeks and Germans and Dutch people to create four, five or six official languages in the various regions. If you made a state with an official Italian language, be sure to incorporate minorities with another language or two. Otherwise it won't work or create the full effect. It would also help to have several of these states drive on the right side of the road and others keep to the left. It would be a nice project in operational research to work this out in such a way that you would get the maximum number of collisions. If this experiment were done and we then, ten or fifteen years from now, compared your America with Europe we may well have bridged the gap, whatever it is!

Dr. Hollomon: Are there comments from the floor? Yes.

Mr. Rodney W. Meyer, of Hughes International Corporation: I would like to comment please. If there's a more technological group in the world than our company, I'd like to know where it is. We spent about 30% of the year, each year for ten years, in Europe and I'm going to take advantage of Mr. Peterson's characterization. I'm one of those fellows that divides people into two groups. Europeans divide themselves in two different classes. One, those that apologize and, two, those that work. Now let me be specific. In Mr. Major's country, Tandberg, as far as I know, makes the best hi-fi tape recorder in the world. I, among other people, have gone to the man who invented it trying to persuade him to use better components, and he says, "I'm not going to change a thing, it's the best there is." And he's right. I think the Norwegians are doing a great job. I know this, I never heard a Norwegian apologize for being a small country.

Phillips Radio has something like eighty percent of the sonars designed to find fish, used in fishing fleets of the world. Their competitors are Raytheon, Siemens Electric and RCA. So there's no problem in being small, if you want to get to work.

Dr. Hollomon: We will let you reply to that Mr. Major.

Mr. Major: I don't think it needs any reply. It is quite true that we have some few people that are exceptional. I think that you will find that everywhere. But what we are talking about here is more of a general situation in Europe.

Dr. Hollomon: One might make a general point that in this country, too, small companies, starting new technical enterprises, don't have large markets initially. They are not even competing for a large market. They start with small markets and then grow those markets. That is true here as well as anywhere else in the world.

Are there other comments from the floor?

Mr. Zvegintzov: I am from the National Research and Development Corporation, United Kingdom, a government-supported effort to encourage the development of government-devised technology in the private sector. I was extremely glad to hear what Professor Quinn and Mr. Peterson said. It looks as though your problems of this country are almost the exact same as those we are identifying in Britain today.

I heartily agree with Professor Casimir also that there isn't *the* technological gap; it is primarily the organizational environment, the management, the dissemination of knowledge through the training of executives that accept and adopt what already exists.

We have based our organization on the principle that the best place to apply government R&D results is in and through industry. The job of research and development is to make money, not to give people fun; that's a by-product. What we do is to invest just enough money into our industrial partners to make them give our R&D developments sufficient priority to convert them into commercial innovations. We are providers of revolving funds of risk capital. In the event of success we get the capital back through royalties on the exploitation and commercialization. In the event of failure, we have lost our money. We can't say yet what the time cycle for full recovery is; it may be twenty years; it may be twenty-five; I can't say. But the effect is one of adding the catalyst to the business enterprise; the acumen which exists in industry sometimes requires a bit of an extra boost when new technology is involved.

Dr. Paolo Rogers, Olivetti Co., Italy: Mr. Chairman, from what has been said in this discussion it will appear that this symposium is about to conclude that there is no technological gap. If this is to be the consensus, I would like to register a dissenting vote. The gap may not be purely technological but there is definitely a gap, with a capital "G"—Europe and America are growing in different scales in different directions, and this is creating a very dangerous gap indeed within the Atlantic world. It may be due to poor organization, to inadequate dissemination of information, to lacks in management, to limited R&D, and to insufficient applications or use of fundamental research.

The semantics aside, Mr. Chairman, I think this meeting must recognize that a dangerous gap is developing and that we need to find ways—for both sides—to deal with it.

Professor Quinn: I would just like to make a brief comment on that. I think that the gap that you refer to is genuine in certain areas. To me, one of the very important aspects that has not been emphasized in the discussions so far is the matter of the large initial demand and opportunity for relatively low-level technological skills. I go into many European bakeries, drug stores, groceries, et cetera, and see that simple time and motion concepts would release people into the society for much greater additions to production. This is also true in the underdeveloped nations where relatively simple technologies would release large numbers of people to do more productive things. I hope that this will be recognized in our conclusion here. The gap has many dimensions; it is not solely one involving complex technologies.

Dr. Hollomon: I would like to make one comment myself; I don't think anyone here is saying that there are not differences. Dr. Casimir has said, too, that it is neither simple, nor a single difference. There are many complex differences. Comparable differences exist right within the United States. We have those who are in the space and military efforts, which are at the forefront of technology, because the problem there is not one of cost but of performance. It is a difference which exists between the highly sophisticated scientific and technical business that depends almost solely on technology and the rest of the business world.

I don't think the world is moving apart. There are new and highly sophisticated technical businesses which the world has never seen before and we happen to have a lot of it here. The same techniques that apply to these highly sophisticated businesses do not necessarily apply, as Mr. Quinn has said, to the economy of the less developed country. We must learn and appreciate that there are different sciences and technologies that apply to that situation. That's the difference to which you refer.

I'll take the prerogative of having the microphone and comment on Prof. Rao's arguments. I agree that the difference in technology between the less developed countries, and the European, American, Russian economies is a much more substantial problem than any small disparities between us and Europe, or even between Mississippi and New York State—the latter, by the way, is a large disparity, too.

That difference is much more one in management skills and entrepreneurship than the differences that have been stated to exist between us and Europeans even though those are significant too.

One of the great mistakes is that, as Prof. Rao mentioned himself, India has tried all the techniques that we suggested. It may be that those techniques only work for a highly developed country. They may not work at all for the kind of country that he is talking about. Entirely different means may be appropriate; we need to find them.

Let's look at our own case, that of the United States. When we began to grow seventy-five to a hundred years ago, there wasn't much R&D. We didn't have scientific advantages; we didn't have a national policy on educating scientists and engineers. We didn't have a national research and development corporation. We didn't have government contracts to industry. None of the things which these gentlemen have suggested were available during the great take-off period of this country, which changed it from an agricultural economy to a manufacturing economy. We used entirely different techniques during that period of our development. Perhaps you don't teach to all those young people in India the same kinds of sciences we *now* teach. As the Vice President said last night—the "ics", nucleonics and physics and what have you, may not be the best approach. It wasn't what we used, for whatever that's worth.

We made, in this country—the greatest political experiment that any country ever made—by establishing the land-grant colleges, the state universities that taught the farmers and diffused the growing body of knowledge in agricultural technology. That was done by a national program, and it was done by a pluralistic decentralized institution, primarily by man-to-man conversation and education.

All I'm suggesting is that for a country like India or Vietnam to believe that the methods which work today for the United States or Britain or Norway would work there is, in my opinion, a grave mistake. The application of the most modern sciences may not at all be appropriate. We don't really know the soundest approach.

Luncheon Program

Introduction: Mr. Alexander B. Trowbridge
Assistant Secretary of Commerce for Domestic and International Business

Mr. Trowbridge: The site for this conference, these magnificent facilities of the National Bureau of Standards, are clearly the products of a highly advanced economic structure. This new industrial revolution today is based upon the burgeoning technology, and the developed nations of the world lend new impetus to that revolution with each day of new inquiry and innovation.

From all that has been said so far in this symposium, including Mr. Rao's remarks just before luncheon, it is abundantly clear that we must focus on the position of the developing nations of the world who are not yet fully engaged in the development and utilization of technological progress.

Mr. Reynolds raised this issue yesterday when he said we would probably be judged 50 years from now more closely on how we have dealt across the Equator, rather than across the Atlantic. And the Vice President eloquently spotlighted this area of concern last night in his challenging talk at the banquet.

What has been done—and what more should we be doing—to make technology available to nations at all levels of economic development?

Secretary Connor said yesterday that our efforts should be aimed at removing barriers and obstacles, and I can only re-emphasize that this is indeed the policy of the United States Government. We support and encourage the transfer of our technology to the developing countries. The achievements of American research, the products of our free enterprise system, are available under the patent process throughout the world. We have active programs in promoting U.S. private investments, licensing agreements and joint business ventures with all the peaceful developing countries of the world.

And these programs are bringing with them the best of our technology and know-how. The coming year will be very important for the less developed countries, for it is then that the long-planned international symposium on industrial development is scheduled to take place—probably toward the end of 1967. We hope that this symposium will do much to focus the attention of the developing countries on what practical steps they can take to realize their industrial development potential. We, in the United States, will give our full support and encouragement to that symposium, to which our next speaker has already given great leadership.

It is a great honor and privilege for me to be able to introduce to you the United Nations Commissioner for Industrial Development, Dr. Ibrahim Helmi Abdel - Rahman.

ALEXANDER B. TROWBRIDGE *is Assistant Secretary of Commerce for Domestic and International Business. Prior to assuming this post in early 1965, he was President and Division Manager of the Esso Standard Oil Company of Puerto Rico. He was formerly engaged in the overseas operations of several petroleum companies in Cuba, El Salvador, Panama and the Philippines.*

A native of New Jersey, Mr. Trowbridge is a cum laude graduate of Princeton University (1951) where he majored in the Woodrow Wilson School of Public and International Affairs.

Mr. Trowbridge has written of his overseas business experiences as a contributor to Harlan Cleveland's "The Overseas Americans" and was a consultant in the preparation of "Spearheads of Democracy—Labor in the Developing Countries," by George C. Lodge.

Speaker: Dr. Ibrahim Helmi Abdel-Rahman
Commissioner for Industrial Development,
United Nations, New York, New York

Address: **Technology and the Developing Countries**

Dr. Abdel-Rahman: In my early days, I didn't hear much about "science and technology." We used to hear about science only. Everybody spoke about science. I think this combination, science and technology, is relatively recent in literature. Even at UNESCO, which was established 20 years ago, they included science with a capital "S"; and even this was introduced with some difficulty in those days. Now nobody mentions technology without science, or science without technology, and it seems that they are very much related.

Another word combination so often heard is "Research and Development." I think this is an invention of the American corporation. Of course, it may not be a monopoly. R&D is now a recognized combined function: you don't speak about research without development, or development without research.

Then, "transfer of technology." Transfer of technology has been mentioned, I think, about 3000 times in the last day or two, but how do you transfer technology? In books? By moving people? By what? What is technology itself?

The Process of Transferring Technology

The "transfer of technology" reminds me very much of a blood transfusion. You know that for a healthy body you must have blood. In certain situations the blood is not there, so you choose some good blood and inject it by transfusion. Blood by itself has little value; however, blood within the body is of paramount importance. Along the same vein, it seems to me that even a whole room full of technology put in books or on "microfilm" won't do anything. I want technology to be inside the body. I want it to be inside a production process. I don't believe in technology by itself.

Technology is generated within a system, and similarly is transferred and transplanted within a system. You cannot speak about technology separate from the system in which it works. People study blood, blood diseases, and blood circulation, but they don't study them for their own sake. Blood is thought of as a constituent of a system.

What I mean by this anology is: In the advanced countries you have a system which operates the processes of production, of consumption, of creation of needs; you have research and development, and within this system technology moves; there is a cycle; there is a living body.

Technology in the Economic Cycle

When you go to the developing countries, you don't find this cycle. I think this is more or less what Professor Rao has been saying this morning. In his country, and my country, we do *not* have such a cycle, which goes this way: first you have production of goods, and services; then you have the purchasing power to buy this production; you have the incentive to increase production; finally, you have the technical capacity, the ingenuity for creating new techniques and procedures—that is where technology goes into the circuit.

You can have institutes studying blood and institutes studying technology, but these by themselves do not complete the cycle.

Here at the National Bureau of Standards—and I'm so glad at last to be visiting this place—here you do not concern yoursleves directly with economics, you don't think about national consumption directly. You work on certain aspects of technology and development, but there are existing connections carrying whatever is going on here into the mainstream.

In the developing country this is not so. There is no cycle. They get industry from outside, they get technology from outside, they get science from outside—but inside the country, there is not enough circulation.

The mechanism of the body there is not working properly. This means that we need to activate this cycle of life in the developing countries and to inject into this cycle the life-blood which is technology, in a way that will produce a growing economy. To me, this is more important than speaking about the "gap" and the "levels."

Can we put dynamics inside societies so that they grow and generate their own energy and exercise a variety of functions? Can we get modern technology, advanced technology, to be a help in that?

IBRAHIM HELMI ABDEL-RAHMAN *is Commissioner for Industrial Development for the United Nations, an office he has held since appointment by Secretary-General U Thant in 1963.* Following twelve years as a member of the faculty of Cairo University, Dr. Abdel-Rahman became the first Director of the Egyptian Atomic Energy Commission, occupying this position from 1954 to 1959. Concurrently, he was Secretary-General of the Council of Ministers and the National Science Council, and was Under Secretary and head of the technical staff of the National Planning Commission of the United Arab Republic. He also headed the U.A.R. delegation to the International Atomic Energy Agency in Vienna and was a member of the UN Conference on the Peaceful Uses of Atomic Energy.*

Dr. Abdel-Rahman, a native of Sharkia, United Arab Republic (1919), received his Bachelor of Science Degree from Cairo University, followed by post-graduate work leading to a Ph.D. degree from Edinburgh University. He also accomplished post-doctoral work at Cambridge University and later at Leyden.

**On December 6, 1966, Dr. Rahman was appointed the first Executive Director of the United Nations Industrial Development Organization (UNIDO) by the UN General Assembly. The functions of the Center for Industrial Development have now been transferred to UNIDO.*

There are economic levels, there are social levels, there are philosophical levels. If you like, there are "technological" levels. This differentiation by levels, as we have been told this morning, exists even in the United States—between industry and industry, and between state and state. Can one conceive of a society where all levels in all directions are equal? I think it would be a very dull place, by the way!

How Can Technology Help Start the Economic Cycle of Life?

What is needed is to recognize that in the underdeveloped countries, the poor countries, the cycle of life is not really working. We have to see how can you transfuse the technology which is already available—not as something in itself, but in order to create this moving cycle.

Technology used in production, whether agricultural production or industrial production, is the technology most necessary in the developing countries. Yet the developing countries, without having this technology, can utilize outside technology. In my little village in Egypt, the farmer boys have transistor radios. We have television, motor cars, jet planes; we are asking for and obtaining levels of life which are drawn from outside. Needs are created by this. But we do not have the corresponding industry that will produce these requirements at home or produce the wealth with which to buy these needs. This disrupts the balance between technology of production and—for the lack of a better word—I call it "modernization." In the underdeveloped countries, we aspire and do modernize our life by utilization of the cinema, radio, television, and health activities. But we are not so capable of increasing our industrialization.

All the while, through the integrated system I referred to earlier, these two functions (industrialization and modernization) are moving in parallel paths in the advanced countries. You are producing color television, you invented color television, you are the consumer of color television. You have production, utilization of technology, consumption, moving parallel to each other. So, economically, this is a viable system.

We in the underdeveloped countries are exposed to the results of technology, but there is a lag between industrialization and modernization. What should we do to correct that?

Three Possible Strategies for the Developing Nations

A very easy reaction would be to shut oneself off completely from the outside and stop this modernization. You could continue living in the underdeveloped countries in the life of the Middle Ages. So the readiest solution is the solution of isolation.

A second solution—just as an alternative—is to create a selective barrier that will allow the technology of production to pass through but keep out the technology of consumption. We could stress heavy industrialization, we could stress modernization of agricultural production, but not have shoes or shoemakers, not have houses, not have television, until we build industry first. We could subject our political system to this requirement, forcing the whole energy of the society into trying to make production and consumption come closer to each other to create a balance. This is a second alternative.

A third alternative is to see that you get from the outside not only the television and other modern innovations but also some support to be able to pay for television, and innovation. Today, we get support for industrialization. But Dr. Rao doesn't want support. He is too proud. He wants our countries—and I agree with him—to be capable of producing things by themselves. We want to share in the human development. We don't just want to be handed down things. I think Professor Rao will agree with me, that for a certain stage, outside help is needed, both economic and technological, provided that this outside help is going to lead to increased vigor, and fuller life and development of the developing countries. It doesn't matter if it takes long, provided we can really get working.

The Disillusionment with Foreign Aid

This brings me to some of the disillusionment which we are experiencing about foreign aid. Twenty years ago, as a result of the Second World War, we in the underdeveloped countries passed into a stage of political maturity—a stage of de-colonization, a stage of emergence of new nations—though some are very old peoples. We recognize that political independence, though necessary, is not sufficient. We also need economic availability and social change. The same principles were recognized fully by the advanced countries, including this country. This country created Lend-Lease during the war—a concept of sharing responsibility for victory—and this country developed, also, foreign aid as a concept for joint responsibility in peace.

After 20 years, there is disillusionment. In my opinion, this disillusionment comes from the fact that we underestimated the task and overestimated our tools and facilities for tackling it. We assumed that a certain amount of aid was going to generate miracles, and that provided one does this trick or that, developing societies could change immediately. What we are discovering on both sides—the advanced countries, and the underdeveloped countries—is disenchantment and disillusionment because the results are not up to the level of expectation. The difficulty is in the original expectation, not in the actual result. The original expectation was too high, and not based on real experience. Now we have 20 years of experience and we should reexamine this situation. If this were done, we would find that what is needed is a better method of enabling the developing countries to come and share in world activity for everyone's mutual benefit.

I would like to comment also on the several points which Dr. Rao mentioned this morning. I am on the best terms with Dr. Rao. We know each other, we admire each other, but I have some comments nevertheless.

He speaks about an international technology agency. Translated into my language, he wants a world blood-bank. I *don't* want that. I don't think you can store technology and then press a button, and technology will flow. What we need is something different; namely that when you come to a country to establish an industry, available knowledge and experience that will create the physical productive entity must be examined first. In other words, I want technology to be embodied in an operation and a system; I don't want blood in test-tubes, I want blood inside living people. I am happy to see that Dr. Rao agrees with me.

In a second point, Dr. Rao wants almost a supersonic system of education. Within six months or a year he would like to educate people to be technically and functionally literate. I leave it to more capable people than myself to see if this can be done. I believe it should be done as part of a specific activity rather than just teaching technical literacy for itself. If you have a factory—and this has happened in many places—and you take people who have never had any technological experience, and you give them training on the spot in a specific field, they acquire the necessary training to fit into the activity. We have seen this in the army technical services, we have seen this done in other fields. The question is not the transition from the unskilled worker to the skilled worker when you have provided the organization that will supply him with real work. I don't object to Dr. Rao's appeal for rapid literacy if it can be done, but the essential point here is to believe that given proper productive facilities, the human interest and the basic capabilities, it is not difficult to build up the trained personnel required. Training and industrialization move together.

On a third point—about export promotion through joint enterprise—let us wait until the afternoon session to hear more about it. Let us see, if the experts think it is feasible to establish modern industrial production facilities on an appreciable scale in the developing countries—with the participation not only of foreign capital, but also of management, and export marketing—so as to utilize the labor and the raw materials of the developing countries in an increasing production based partially on the market demands in the advanced countries. This is a very serious question before us and it ties in with the last of the alternatives I proposed before. If we do not want the underdeveloped countries to shut themselves off from the world, and if we don't want them to move in the direction of heavy industrialization exclusively at any cost, the policy to follow is to give them a chance to develop their resources jointly with the developed countries in an activating process.

The Corporation as a Catalyst in the Development Process

This brings me to an observation about the role of the corporation. I am not referring to the private corporation, or the public corporation, but the corporation as an institution. In the last 20 years or 30 years the corporation, as an institution, has faced two very difficult battles successfully.

The corporation has succeeded in the battle of labor. You now have the corporation working fairly well with labor. That was not the situation in 1900 or even in 1930. In those days, whenever you spoke about social legislation for the improvement of the lot of labor, it was taken to be against the corporation. But in the meantime, we found it is possible to have successful corporations with stronger labor participation and higher standards of living for labor. That is a very important achievement; it is the first of the two battles that the corporation as an institution won—namely succeeding in making peace, and collaborating with labor.

The other battle, which I think the corporation also won, is the one with the public authority. In this country and other countries we wanted to find out whether the corporation could live in a society in which central public authority has to exercise certain functions. Less than a decade ago this was supposed to pose a conflict. With the corporation having interest on one side, and public authority having interest on the other, it was said that the two would have to fight each other, but we have found out instead that the corporation as an institution could live and cooperate with public authority, and peace between the two could be obtained.

A third and new battle is coming up for the corporation. The corporation must recognize its international role and responsibilities. This is where the question of export and joint enterprises comes. If you have a corporation in America, even if it is 100 percent private, it must be recognized that, inherently, while this corporation my be working in a specific industry, it has also an international responsibility. It does not just have responsibility toward the shareholder, which no one would deny, but it has a certain responsibility toward the public of the country in which it is domiciled. In addition, there is also an international responsibility. This international role and responsibility of the corporation is, I think, what we are trying to discover, and which may hopefully be very useful in solving some of the questions which Dr. Rao has put this morning, namely, to establish effective machinery for the transfer of technology.

What Future for the Developing World?

I don't want to be an alarmist. On the contrary, I am an optimist, but I feel that—from my limited experience in the United Nations and in my own country and in the fields of science and administration in which I have worked—the developing countries within the current system of relations don't seem to have much of a future. This is very serious. This will become more and more apparent. The balance of payments, the difficulties of foreign exchange, the political instability, all of these are symptoms which are appearing in one form or the other. They are symptoms of the underlying fact that the present set of relations are not capable of being endured by the developing countries for long. There must be some basic change in thinking if we want to bring the developing countries—which represent two-thirds of the human population—into an active participation in the affairs of the world and to guarantee them some hope for the future.

As things are, I cannot give the developing countries any picture of optimism for the future. After 20 years of effort, after all the aid they have taken, after all the good wishes and the resolutions they have received from the UN—where are they now? On what basis could you tell them that they have a future?

In line with the title of this luncheon's discussion, in my opinion, this calls for a very intensive examination of how to get technology, which is abundant here, to work in these countries—the technology of getting wealth, the technology of getting the progress which has been achieved here, to be realized there.

The Need for Better Ways to Industrialize

The technology is available. But how is it to be built into the systems of the developing countries? If we cannot do that, and do it quickly and with effectiveness, I don't see how the picture can change; instead I can imagine a lot of deterioration.

How can it be done? I think this is a matter for examination. We in the UN have hardly started defining the problems. Referring back to the international symposium that the UN Center for Industrial Development will sponsor within a year, we find that there has never even been an international meeting on industrialization before—never. Nobody thought of it. People have spoken of specific industries or certain aspects of industrialization of the developing countries; but to make it the total subject matter of an international meeting is new.

We hope this coming symposium will be useful. We hope it will be useful in the sense of discovering the dimensions of the problem. We hope it will speak straight to the developing countries, because they, too, have made mistakes. There are bad administrations; there is bribery; there is laxity in the determination of policy. There is confusion of political factors and economic factors. There may also be prejudice against foreign participation, which may or may not be justified. There have been mistakes, and there are shortcomings.

From the side of the advanced countries, one also has to admit, with due respect, Mr. Secretary, that the advanced countries will have to learn also. They should be shown—with all good intentions—that they have given aid for 20 years which has not succeeded as much as it should have. Why is this so? Is it that more of it is needed, or that other methods are needed? How can we increase confidence between the two groups of countries. How can we get the activation process I spoke of earlier going?

The United Nations Symposium of 1967: Its Purposes

So, we hope that some of these questions will be posed in the International Symposium. I am not saying that they will be solved, but it will create a better understanding of the dimensions of the problem.

We also hope that the new Organization for Industrial Development (UNIDO), which the United Nations is setting up now, with the full support of all countries, will play an important part in building this understanding.

In the marvelous little booklet which I was given last night to read, on Science and Technology for Mankind's Progress, I noted that the United States is spending 22 billion dollars on research—16 billion by government and 6 billion dollars by industry. I was wondering, could we take one percent of this to examine the effectiveness of the available methods of industrialization?

We must define the problem. The advanced countries are spending money. They are giving aid. They are giving loans. Would it be worthwhile using just one percent of this total—to see what is the problem and where are we going?

I want to leave you with this idea to consider.

November 17, 1966

Afternoon Session—The Transfer of Technology Through Enterprise-To-Enterprise Arrangements

Mr. Stern: In this afternoon's session, rather than being concerned with the role of government, we shall be concerned with the role of enterprises, primarily private, and examine their role and effectiveness in the transfer of technology throughout the world.

The chairman of this afternoon's session is a scholar of this field, Dr. Hollis B. Chenery of Harvard University.

Dr. Chenery: I assume a professor has been invited to be chairman because he looks at this problem from the outside while the other speakers are directly involved in the process. I have some observations on the process from my vantage point but I shall wait until the formal participants have spoken and then comment on some of their themes later on in the discussion. However, I would say that in my period with the U.S. Agency for International Development we were always impressed with the fact that the reservoirs of expertise and the resources to transfer technology were largely in the private sector, and that the government was essentially on the side lines, trying to motivate or facilitate private activity. To get anything really done on the technological side seemed to require private actors. It was much easier to get a dam or a steel mill built than to get the manager for it and particularly the system, as Dr Hollomon puts it, in which it was going to fit. Governments were really only observers in these aspects.

HOLLIS B. CHENERY *is Professor of Economics at Harvard University. Currently his research at the Harvard Center for International Affairs is directed at developing quantitive analytical techniques for the study of economic development.*

He formerly served as Director, Program Review and Coordination Staff, Agency for International Development (U.S. Department of State), and from 1962 to 1965 was Assistant Administrator for the Agency. Dr. Chenery's early career included engineering assignments with the Phillips Petroleum Company and the Southern Natural Gas Company. Dr. Chenery has also been Economist with the U.S. Economic Cooperation Administration and Chief of the Program Division of the U.S. Mission to Italy for the Mutual Security Agency.

A native of Richmond, Virginia, Dr. Chenery received his B.S. degree in Mathematics from the University of Arizona and in Engineering from the University of Oklahoma. He was awarded his Ph.D. in Economics from Harvard University in 1950.

Dr. Chenery has carried on many international economic consulting and advising assignments. Turkey, Italy, Pakistan, Japan and Israel are among the countries he has thus served.

Dr. Chenery: I would like to proceed with the formal program. Our first speaker is Mr. Elmer S. Groo, Vice President of I.B.M. World Trade Corporation.

Mr. Groo: Mr. Secretary, ladies and gentlemen, I'd like to discuss this afternoon some of the issues that affect the way a business corporation does business overseas. In particular, I'd like to focus on the size of markets compared with the size of technology as measured in terms of its cost.

Historical Experience in International Exploitation of Technology

The basic question in introducing technology abroad, is always the market. Traditionally, international business has been effectively organized as a group of self-contained national markets. Cultures, customs, language, laws and national tastes have tended to define markets in terms of national borders.

•Two decades ago, technologies were simpler and investments in development were, by today's standards, rather modest. Technologies like jet aircraft, color television, computers, with their development costs running into hundreds of millions of dollars, were simply unheard of.

It was possible in those days to bring a product to market with expectation of a profit in the relatively limited scope of national markets.

The Need for International Markets

The burst of technological developments of the last two decades, with their enormous costs, has demanded the expansion of markets. Almost the only market that will justify some of today's advanced technologies is America. And for a company based in Europe or Asia, or for any company engaged in national trade, a single unified international market may be required just to justify the cost of technological advancement.

There are all kinds of recognition of this fact around us. The growing emphasis on international standards, the concept of a European Common Market, and the emphasis by every industrialized nation on exports. All of these are really a recognition of the need for international markets.

The Conflict of National and International Markets

Yet, the fact is that national markets do continue to exist. Each nation has its goals; each nation has interests of its own which influence its laws and which dictate common-sense rules for good corporate behavior there.

So we find a conflict. On one hand the company seeks an international market to support its investment in technology. On the other hand it must satisfy the national markets and the special needs and interests of a national economy. So the problem is how to organize in such a fashion that we can meet these conflicting needs.

IBM's Approach to the Conflict Problem

Without trying to speak for American business in general—I'm sure there are great differences between companies—I'd like to describe how we approach this problem in our own company.

We start with the assumption that the need for our products and the function they perform are pretty much the same around the world. There may be differences in details but these are a matter of adaptation, not basic to the design of the machines. So the technological side of our business is run essentially on a uniform, world wide basis.

Our second assumption is that we must operate in a given country as a part of that country's industrial economy, responsive to national goals and interests, and equipped to provide the same level of support and service to the customer that we would in this country. This means that we need a strong autonomous country operation.

Let me illustrate, using France as an example. I.B.M. France is not our largest operation, but it's one of the largest. It has eleven thousand employees, thirty branch offices, two manufacturing plants and a product development laboratory. The employees are all French, including the general manager. We learned long ago that we could not really satisfy a market as well on any other basis. With an American running an operation in a strange language and a different culture without an emotional commitment to the country, we could not learn as well the needs of the market nor the interests of the government, nor could we find and hire the best people or manage them with the same appreciation and understanding.

ELMER S. GROO *is Vice President of IBM World Trade Corporation. Joining International Business Machines Corporation in 1941 as a Sales Trainee, he became a data processing sales representative in Philadelphia and was then sent to Washington, D.C., as a special representative. Following a four year naval career, he returned in 1946 to a sales assignment in Philadelphia.*

After a period in sales and sales management, he was assigned special duties in the office of the Executive Vice President, subsequently being appointed Executive Assistant to the President of IBM in 1956.

He was elected Vice-President in 1959, being responsible for European Operations for a two year period. His present responsibilities include Personnel, Communications, Executive Development, Government Relations and Administration.

Mr. Groo is a graduate of Drexel Institute of Technology. Mr. Groo is a Director of the Business Council for International Understanding.

The principal preoccupations of the general manager of I.B.M. France, are marketing, personnel and finance. His responsibility for the laboratory is only administrative. In manufacturing, his responsibility is somewhat broader but it is still limited to executing a plan worked out with manufacturing management at our international headquarters. While his advice and counsel are valued and often asked for in regard to manufacturing, both as it applies to France and as it applies to the total I.B.M. interest, he alone does not make a decision as to what products will be produced in his plants nor does he determine production quantities. These are a matter for international decision because his plant is producing for the international marketplace.

When it comes to personnel, he has complete responsibility to find and hire and train the people he needs. In marketing, again his responsibility is complete. He gets help from the outside when he asks for it, but basically he has to sell and service the market.

Above all, he is responsible for our corporate posture in his country. It is his job to know market needs, the attitudes of his government, the requirements of his laws, and to see to it that we conform to them. He is the spokesman for what is best for I.B.M. in his country and, I assure you, we take his advice.

We bring together the interests of I.B.M. France and the interests of the total corporation through an annual planning process. All operating plans originate within the country. They are worked up through several levels of management and finally consolidated on a worldwide basis in the United States. During the process there is a good bit of negotiation on sales targets, marketing programs, the investment of funds and a host of other considerations.

When the final plan is reached, the country general manager has specific operating goals and responsibilities which he executes according to his own judgment. In this way, although he may not decide the final mission of his laboratory nor the products to be produced in his plant nor the volume of his production, he has a clear understanding of his responsibilities which effectively enables him to manage the operation in his own country.

Management of Technology on an International Scale

Now looking at the other side of the picture, with all the variations in laws, customs, individual product needs and the need for responding to national objectives, how do we manage technology on an international scale?

Well, first, when we plan a product we do it on a worldwide basis. While final specifications are determined at the headquarters of our development division in this country, they reflect inputs from at least twenty countries around the world. Our product planners receive market requirements from all of our large countries, so that when we announce a product, we know that it will meet the needs not only of the United States market but virtually every significant market abroad.

All of our computers, for example, handle not only decimal arithmetic but sterling as well. Our output printers can print not only Arabic characters, but the Katakana alphabet used in Japan. Our typewriters can be supplied with type faces for any one of 22 different languages. Our banking equipment deals equally well with American or European checks.

Incidentally, one of the beliefs that seems to persist is that the country less developed industrially will be willing and satisfied to buy the products of yesterday's technology. This may be true in some industries but it certainly is not so in ours. Developing nations are aware of today's technologies; they are not willing to go through all the steps of development that we have in the West. Our African customers buy the latest, most sophisticated computers we have to offer and we have such machines installed today in some inaccessible areas of that continent. We have learned not to look upon these areas as second markets for yesterday's products.

International Diffusion of Development Responsibility

It is one thing to plan a product on an international basis and it's another thing to develop it that way. Yet the pool of technological talent is an international one, and the ideas that contribute to the advancement of our particular industry have come from many countries around the world. We have six research and development laboratories in Europe and today we use those laboratories as part of a worldwide development organization.

This was not always so. For some time we used our European laboratories primarily to support the local market. Fifteen years ago, when technology was simpler, this worked pretty well. As time moved on we found it harder and harder to make full use of the talent we had in limiting their mission to the needs of a single country or even to a single continent.

When in 1961 we undertook the development of a new line of compatible computers in a new technology, later announced as System 360, we made the decision to bring the European laboratories into the worldwide development program. The 360 line comprises six basic computers, compatible in concept and ranging in size from one designed to meet the needs of small to medium business, up to a system of great speed and capacity for the most complex computing requirements.

The architecture for this system came from a variety of sources, with several basic concepts originating in our European laboratories. Once the several units in the line were agreed upon, each laboratory, whether U.S. or European, was given a specific mission. The smaller machine came from Germany. The medium-sized machine was designed in England, the larger computers in our U.S. laboratories. The French, Dutch and Swedish laboratories, as well as laboratories in the U.S., produced a variety of input/output equipment necessary to apply the computers to the wide variety of applications for which they were to be designed.

In developing a single, compatible commercial product line, we obviously had a special need to maintain constant liaison between laboratories in the U.S. and our laboratories in Europe. With the magic of today's communications technologies, we were able to set up a network between the U.S. and Europe, and by use of fascimile equipment to transmit not only messages but drawings as well. An engineer in our laboratory in Poughkeepsie, New York, could talk with and jointly design circuits with an engineer in Hursley, England, transmitting designs back and forth as they worked.

Although we do not take the credit for it, we think the day-to-day relationships between our engineers, which were made possible by this network, represented a great advance in bringing the technological abilities of a lot of nations to bear on the solution of a single problem.

Manufacturing in Local Markets

We've talked about planning and we've talked about product development. The final step in our technical process, of course, is manufacturing. We plan our production programs on an international basis but we believe in manufacturing in a local market whenever the economics of the situation allow it.

There are some technical advantages in terms o closer support for products in the field. Certainl transportation is simplified and, at least in the Com-mon Market, the duty picture is more favorable The most significant reason, however, that we manu-facture abroad, is that it involves us in the loca economy in a positive, contributory way. We emplo people, we buy parts and components from local in-dustry, and we contribute directly to the export pro-grams which are so important to a national econ-omy.

Training of Work Forces

With all its pluses, the manufacture of a compli-cated product in more than one location poses som real problems, especially when the manufacturing lo-cations may be thirty-five hundred or even eigh thousand miles apart. There are, obviously, som duplicate investments in production equipment Much more important are the duplications in th training of a work force. Our particular product involve a high skill-level, and we expend a grea deal of time, money and effort in assuring that ou people have the same level of training in every loca-tion.

One of the things we do to meet the training nee is to transfer people for a temporary period of six o twelve months to laboratories where products ar developed and to plants where technical control wil remain. The people return as fully trained as thei counterparts in other plants and can act as a skille *cadre* to set up a full work force when a product i released to production.

Standardization

We make a special effort to maintain worldwid engineering levels. We believe that this is fundamen-tal for many reasons, not the least of which is pro-viding the same services to our customers, regardles where they are. To start with, we have an activ effort in standards. An important segment of our en-gineering force is devoted entirely to the problem and all of our specific product design is execute against a predetermined set of standards. Desig drawings carry both the Anglo-American system o feet and inches and the metric system used by th rest of the world. This gives us a common base, an as we make improvements in products—and we d —we transmit from the point of engineering contro to all points of production, via computer, the lates engineering changes on an overnight basis, so tha they can be reflected simultaneously in current production at all points where the machine is made.

Function of Patents

Another facet of our efforts in technology and which has to be an influence in any fast-moving field, is that of patent protection and access to the patents of others. We maintain patent departments in the larger industrial countries of the world and we file our patents on an international basis regardless of their source. An active program of licensing provides the freedom of action that enables us and others in our field to develop and bring to the market products of the latest technology, without fear of accidental patent infringement.

IBM Looks at the Future

A Symposium such as this is concerned as much with the future as it is with today, and I'd like to take just a minute to talk about the future.

Recently we conducted an experiment with high school students in New York City. Through telephone connections, they had access to a computer at our research laboratory in Yorktown Heights, New York, which helped them do their mathematics homework. Professor Quinn told me that Dartmouth College is doing the same for students at Dartmouth. On numerous different campuses of American colleges today, computers are assisting instructors in teaching a variety of academic subjects to undergraduates. And early this month the first time-shared system designed specifically for educational purposes went into operation, assisting in teaching over a hundred first-grade students in Palo Alto, California.

A number of hospitals are using computers today to assist in analyzing electrocardiograms, blood tests, and in a series of other diagnostic applications. One airline uses computers to make it possible for an airline passenger in Rome to request a seat on a plane out of New York and to get confirmation from his agent in a matter of seconds. So the time-sharing system, the use of computers in education and medical science are already a reality. In certain fields the worldwide computer network is already in use. These are only the beginnings of what might come about just in our industry in the next ten years.

I'm sure that other industries have the same entrancing possibilities. The significant thing is that the direction of technology continues to move toward serving the individual, whether he be American, European, Latin American or Asiatic.

A meeting such as this, examining the practical problems of bringing technology to the individual wherever he is, is enormously significant. One thing that it underlines is that our success in business organizations will be very much measured by how well we carry our technology to international markets and, perhaps equally significant, how aggressively we bring foreign technology to use in our own market.

Improvements in communications and transportation will create a market demand which is more international than national in character. Television satellites and supersonic flights will certainly break down national barriers. I suspect that there will continue to be nationalism, and national markets, in a certain sense, for a long time to come; but I believe that the mobility of people and the mobility of ideas will assure the fact that there will also be mobility of technology.

Dr. **Chenery:** Our second speaker, Dr. Aurelio Peccei, will give us a European view of some of the same issues. Dr. Peccei as far as I can tell wears three hats. He is managing Director of the Olivetti Company; he is also head of Italconsult, an international consulting and engineering firm which deals with underdeveloped countries, and he is on the Executive Committee of the Fiat Company. He tells me he's going to draw on all of these backgrounds in his presentation.

I might mention my own one experience with the Olivetti Company, when I was working in Italy some years ago. I was much impressed in visiting a new Olivetti plant, outside of Naples, when I was told, first, that almost none of the labor force had had any previous experience with this technology and that the employees had been selected on a psychological basis rather than on their experience, and second, that in two years the Naples plant had reached the productivity of the Turin plant through proper training and proper management. Such transfer of technology within Italy itself is a fascinating achievement because the south of Italy, particularly in the past, has had the same kinds of educational deficiencies as the underdeveloped countries have now. I hope that Dr. Peccei may be able to tell us that such development can also take place elsewhere.

Dr. Peccei: Mr. Chairman, Mr. Secretary, ladies and gentlemen. I am the last formal speaker before the discussion and I suppose that by now, after the brilliant addresses of yesterday and today, you will be well prepared for an anticlimax.

I enjoyed the symposium immensely. I learned very much from the previous speakers and from the panelists, and from the scientists back in the labs as well, but I would flatly refuse to submit to a proficiency test on what I learned.

Before entering into my subject—which, as I understand it, should mainly refer to industrial technology—I want to make a few general remarks. First, I submit that *the problem of spreading technological progress ranks at least equal in importance to technological advance itself.*

The Problems of Technology Transfer

There is a continuous and increased acceleration in the advance of science-based technologies. Under proper conditions, progress has become practically self-propelling. The dramatic technological revolution we are going through is indeed radically transforming our society: it generates "real mutations," a change in kind, not merely in degree. The consequence is that the dialogue, even between two nations, friendly but having a different level of development, tends to become extremely difficult, as if it were between two different species of civilization.

This is why I maintain that, in order to keep a fairly homogeneous pattern of society for the different human groups which should stand together—for instance, the nations we would like to see forming the Atlantic Community—we should devote an equal effort, as we go on producing technological progress, at devising how it can be moved speedily from one country to another in the Community area. Otherwise, this technological bounty, not properly distributed, will become a dangerously divisive factor. And, as we live in a time of history when regional or continental integration and unity has become an imperative prerequisite for orderly progress, if not final survival, this danger needs to be underscored.

When we say that the dimension of the nation-state is nowadays inadequate practically on all counts; when this inadequacy applies equally to nation-groups of sub-continental size, such as EEC and EFTA; when Europe itself is not enough, and our objective has to be "a Europe-plus;" when the very Atlantic Community should be conceived not only as an irreversible partnership among West European and North American nations, but also as the hard core of a wider cooperation area and the rallying point for other important outside regions; then, we must conclude that revolution-carrying technologies should in fact move as freely as possible within the inner Community area; and also in reasonable measure to and from the outer regions flanking it.

This has become one of the urgent and fundamental problems we have in front of us, perhaps not less important for our future than the quest for peace in a nuclear era and birth control in the face of demographic explosion.

Effect of Development Level on Technology Transfer

I have here a second general remark. There are, on the other side of the coin, a great many difficulties in the transfer of technology, however vital this transfer might be. *Among others, a condition to carry it out successfully is the existence of compatible levels of development and organization among the countries concerned.* This means that only in the general framework of compatible development levels can transfer of technology, enterprise-to-enterprise or otherwise, be effective. Experience has shown that to absorb into its national fabric and socio-economic setup the technology which is being transferred to it, the "host country" must be prepared to receive it.

The concept of a compatible level of development does not refer only to the technological gap, which, if too great, would not permit the transplant of technology between two countries. It involves the capacity of the recipient country to live with the new technology, adapting it to its own economic organization, basing on it a process of industrial diversification, assimilating it into its own educational institutions, so that this alien input may be transformed into a national asset.

Effect of Nature of Development Interests

There might be also sectorial incompatibility. For instance, I would question the validity of the transfer to my country, Italy—if it were the case—of some of the U.S. space technology. This type of activity is and will remain for a long time alien to, and therefore its transplant would be incompatible with, her kind of development.

For another example, we may take the Soviet Union. Here we have a technologically and culturally advanced nation "par excellence." Yet her organization level is not compatible with that of the U.S. or even Europe, in some broad and fundamental areas of human endeavour and interest. This is the case of a whole range of mass production-mass distribution activities which characterize our consumer economy. The Soviet system simply is not rigged to take in, and profit by, Western technology in some fields, such as motorization and automation. The transfer from the West to the Soviets of, for example, our automotive technology—planning, designing, tooling up, manufacturing, marketing, selling, financing, handling, servicing and finally destroying motor cars—of course does not present insurmountable difficulties. But even this will require a basic reshaping of the Soviet organization, and sometimes the recourse to odd solutions, such as an extreme verticalization of their manufacturing setup.

This transfer of technology will in any event require rather a long time and, in my opinion, cannot materialize through the effort of Europe alone. The same can be said of another example concerning the manufacture and dissemination of modern office machines in the Soviet administration, which is embarking only now in a process of mechanization and computerization similar to that existent in the U.S. and also in Europe, and which, although so advanced, is nevertheless still in the midst of a further profound evolution. On the other hand, the transfer of technology between countries and in fields having compatible levels of technico-scientific development and organization can be most fertile and effective, as many examples, including that of Olivetti-Underwood, will indicate.

Effect of Stage of National Development

On the other extreme, the less developed countries offer *the most evident necessity and the highest difficulty in transferring technology.* Here company-to-company transfer of new technology can be effective, especially to countries whose system is so different from ours as not to permit an easy transfusion of our technology. I am sure that we are not yet able to assess in depth what might be the aftermath, in third world countries, of the second industrial revolution now taking place in the most advanced countries.

Two-thirds of the world population have not yet adjusted themselves to the first industrial revolution which started more than two hundred years ago. Technologies simpler than those we are now currently considering—for instance those necessary for making agricultural implements, conventional and machine tools and pumps, for improving agricultural yields or better harnessing and using surface water—have not yet been transferred to many of those countries which nevertheless are euphemistically labeled developing countries. The consequence of this maladjustment is unending wrath and turmoil.

Many of these less developed, generally small and often isolated countries, are so attracted by our breakthrough and achievements that they end in aiming at industrializing themselves chiefly along the wrong avenue of the glamour industries and technology. In this manner, efforts are displaced from more useful fields and, if eventually these more sophisticated technologies are transferred, they will be ill

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He has also been connected with the Fiat automotive company since 1930, where he has special responsibilities in the area of international affairs and is a member of the Executive Committee.

A native of Turin (1908), Dr. Peccei received his Doctors degree in economic and commercial science from the Turin University.

absorbed, and cause more dislocation and delays than good. In conclusion, my point is that, as it is difficult to regulate the flow of technology to less developed countries, it is equally difficult to transfer the appropriate technology to them.

Need for Emphasis on Social Facets

This is a major international task. To carry it out we have to concentrate not only on the scientific technologies, but, even more so, on social and political science studies and on social technologies. These latter deserve a higher priority than we have heretofore granted to them. This does not apply only when we deal with underdeveloped countries: it holds also when we look around at our highly developed nations.

To illustrate these points, I will quote from the experience of the companies with which I am associated.

The Olivetti-Underwood Case

The Olivetti experience in the United States affords a case example of the possible transfer of industrial technology, in the broadest sense, between two private corporations, operating in a sector in which the two countries involved have compatible levels of development. It is also a case example of cross-fertilization, demonstrating that cooperation —not only in technology, at that—between Europe and the United States can be a two-way affair, if earnestly pursued.

Olivetti took over control and management of the then Underwood Corporation in the fall of 1959. Initial investment for the purchase of approximately one-third of the Underwood stock was in the order of 8 million dollars. Throughout the years 1960-1963, the initial investment was considerably increased, and today Olivetti has total ownership of its U.S. subsidiary—whose name is now Olivetti Underwood—with an investment of almost 100 million dollars. Yet, in our judgment, even more significant than the size of the investment is the total involvement of managerial techniques in the various areas of the Underwood venture: manufacturing, servicing, marketing, training and management in general.

Olivetti brought to the United States its managerial techniques and philosophy, its industrial design, its salesmanship, its personnel training; but instead of reshaping Underwood merely as a reflection of Olivetti, a new experience was started. Olivetti, in turn, tested and received from this country, through Underwood, new methods and ideas. The result was the emergence of a set of revised technologies in all sectors concerned, which constitute an important asset not only for Olivetti Underwood but for Olivetti as a whole.

Our estimate at first sight had been that the Underwood typewriter factory in Hartford obviously needed substantial rejuvenation; but the vast sales organization of Underwood, spreading all over the United States, should have represented the positive part of our purchase.

The Production Problem

The streamlining of the production facilities at the Hartford plant involved the challenging task of producing at an acceptable cost per unit. First of all, we redesigned the products, pooling together the experience of Hartford Engineers and designers and of our experts in Italy. In this area a fruitful cooperation immediately developed, without friction or delay. Then, to produce a line of new typewriters, the factory was re-tooled with modern equipment and machinery, and new production methods were introduced such as were used in other Olivetti factories around the world. This brought about a rapid transformation of the old factory which, even within its old brick walls, in a few months was put in a position to turn out new products under high standards.

The Marketing Problem

This, however, proved in reality less trying a job than the reshaping of the sales organization, the marketing services and the organization to maintain and repair all models of our machines. Soon after takeover it was realized that to sell and service the range of our products, sales and services personnel had to be trained in great number. This was done on the basis of a crash program which started by bringing to the United States a group of Olivetti instructors from the Olivetti Training Center in Florence.

Olivetti's methods, both in recruiting and training, were already quite sophisticated, and we felt they would provide a positive basis for the rebuilding of Underwood. Yet, as we acquired a deeper knowledge of the U.S. market, we realized that a number of adjustments were needed in our own techniques and methods, to better respond to our new environment. This is the case, for instance, of maintenance and repair activities, where Olivetti's experience had been both original and extensive. However, when we transplanted to the United States our methods for the instruction of service personnel, we found that new methods being explored in this country in the general field of education offered good possibilities of use to us. Thus we were among the first to adopt methods of programmed instruction based on the experience of the U.S. Armed Forces and the studies of various organizations and universities.

Our interest in continuing this process of transferring U.S. knowledge back to Italy is evidenced by our program for retraining Olivetti middle management in various business schools in the United States. Our aim is to expose our management to the fresh influx of modern business teaching, as practiced in the U.S. Also, in R&D, we have developed a regular exchange of information and experience between our base in Italy and the Olivetti Underwood research unit in Hartford.

Personnel Management

In the field of personnel management, we proceeded on the basis of the Olivetti philosophy, which considers the human element as the most valuable asset. This basically humanistic concept, which recognizes in our human potential the greatest element of strength for the corporation, was enforced whenever possible. In this respect one should note that the Olivetti approach was probably a step ahead of the standard U.S. business practices of the time, and we are gratified in seeing the evolution which has occurred since.

As the result of all these combined efforts, Underwood, which for nine years had been a nonprofitable operation, is again in the black, as Olivetti Underwood, since early 1964. Fortune Magazine in its July 1966 issue, listing the major 500 U.S. corporations, singled out Olivetti Underwood for the most spectacular proportional gain of 1965. In this case of technological exchange between Olivetti and Olivetti Underwood, one should say that if it is not unique, neither is it the rule of transfer of technology across the Atlantic. Furthermore, we must bear in mind that its successful and extensive results took place between two companies belonging to the same group.

Other Instances of Technology Exchange

Speaking as an Italian and coming from what is generally considered in the U.S. a "host country," I must say that not always has the experience of transferring technologies from your country to my country been satisfactory, either at the receiver's end, or, I gather, at the giver's end. I will not quote names or point out instances. There is, however, I am afraid, a growing belief in Italy and Europe that the negotiation of an agreement with a U.S. company is extremely difficult when the transfer of important technology is involved; and that its implementation eventually becomes even more difficult in the long run. This is probably due to the fact that a dynamic company, setting the pace in innovation and technological development (admittedly a U.S. company, as this is the most common case) hardly sees its interest in farming out to another company in Europe the most precious ingredient of its success—its know-how or its painfully acquired achievements in R&D.

The U.S. company may be induced to adopt this course (instead of installing a subsidiary directly in Europe, for instance) if it is temporarily too busy at home, or with the aim of gaining a foothold in the European market by a combination with local partners. But generally, once the initial honeymoon is over, the technologically senior U.S. partner, which by virtue of this fact is also the prime mover of future developments, is bound by the logic of its dominant position to escalate its requirements: from a technical agreement to an equity participation, and from a minority position to control of the European company. And this may spell difficulties.

There are, of course, exceptions. Such is the case notably of new technologies developed by small companies which cannot exploit directly in Europe their know-how and patents, and prefer to do it through a license agreement. Another case is when the patentability is doubtful or the patent rights are difficult to enforce. The practice of cross licensing, which is spreading on the spur of these difficulties, may prove very beneficial for a more generalized transfer of technology. Nevertheless, serious limitations remain in the transfer of technology between companies when they do not belong to the same group. And this applies not only to the case of the U.S. versus Europe, but also to that of Europe versus less advanced countries.

Wholly-Owned Subsidiaries vs. Licensees

The example of Olivetti comes in handy again. Whenever Olivetti considers transferring its technology to another country it never chooses to deal with third parties, but rather tends to establish wholly-owned subsidiaries for the manufacture of Olivetti products. This of course is a practice that may not be applied everywhere and therefore has a restrictive element imbedded in it. This approach was followed by us in the United Kingdom, Brazil, Argentina, Canada, South Africa and Mexico, with very good results of technological transfer. One exception is Spain, where simple control of that subsidiary had to be substituted for total ownership, as local regulations limit foreign participation in certain industries.

I know of many other corporations having a similar policy, which, *inter alia,* facilitates a rationalization of production among manufacturing establishments located in different countries. The spread of the multi-national company responds, among other things, to similar needs, and helps the international flow of technology, albeit within a restricted circuit. In two cases Olivetti gave to third parties the license for the exploitation of its designs and know-how. The first case was India, where Olivetti supplied the necessary machinery, licenses and know-how for the establishment of a teleprinter factory, totally owned and operated by a state company. The second case is the agreement still under negotiation with the U.S.S.R. In both cases, this was the sole way to enter a market altogether closed and with a view to furthering future opportunities.

Automotive Industry Examples

Another interesting case of transfer of technology to subsidiary companies tightly controlled by the parent company may be found in the automotive industry. I remember, from my experience, the rather chaotic creation of the automobile industry in Latin America. When the local governments gave a more or less indiscriminate green light, all the interested parties jumped into a competitive struggle to enter those markets, with questionable benefit for either the host countries, the companies, or finally the customers, because of the splinter industries which resulted from this free-for-all.

Only in the case of the American and European motor car manufacturers (General Motors, Ford, Volkswagen and Fiat) which established wholly owned or strictly controlled subsidiaries was the transfer of technology satisfactory. In most of the other cases, if I am not wrong, the experience has been on the whole extremely poor, which confirms the limitations I mentioned above.

As for the recipient countries, they received no doubt an injection of a good dose, perhaps an overdose, of modern technology, which could not be readily absorbed and will require a rather long period of internal adjustments. In fact the intrusion of this most complex industry has caused some severe dislocations in the unprepared economic fabric of those countries which in turn proves, once more, that the transfer of technology is optimal among countries with a compatible level of overall development.

We may conclude that, although private enterprise is the central element of development in the market economies of the Western countries, it cannot be counted on as the exclusive factor for the international transfer of technology. Our corporations must live up to the rules of competition. This very fact limits their willingness to transfer technologies to other companies.

As I mentioned before, the tremendous investments required by modern R&D causes any company to be extremely reluctant to transfer to others its advanced technology, prior to its full exploitation by the company itself, either in the home market or through direct industrial operations abroad. Also, there are other limiting factors.

I am therefore afraid that the open market for technologies, though representing an efficient and fertile exchange medium, is not broad enough to cause the international technological flow to happen at the speed and in the measure which is nowadays required.

In our rapidly changing world we should not feel bound by traditional and established yardsticks. As in the case of domestic basic research programs, funded and handled by public agencies and academic institutions, also for the international exchange of basic and applied technology, a new, imaginative approach should be devised, whereby private ways and means may be supplemented by intra-government arrangements. This point was abundantly and masterfully touched upon last night and this morning. Highly provocative thoughts and questions were advanced.

We have come to a point where action and answers and remedies are required, both at the national level and in Europe. Some agonizing reappraisals are needed in mentality, attitude, education, environment and policies also, with the assistance of the U.S. and at an international level as well.

A Plan for International Cooperation

The plan for technological cooperation recently proposed by the Italian government is meant as a contribution in this direction. This plan calls, in the first phase, for the signature of a technological agreement between the governments of the NATO countries with the possibility for other governments to join at a later date. To reach such an agreement, the interested government should first of all subscribe to a joint political declaration of intent in this vital area, and then call on a special conference to lay the basis for a unified European technological organization which, in turn, may pave the way for a true cooperation, as more or less equal partners, with the United States. Prime Minister Wilson recently outlined a somewhat similar proposal.

The technological organization should promote initiatives, agreements and infrastructures in Europe necessary to foster European technological development for the next ten years. The plan also suggests that European and U.S. cooperation may start with a project-by-project approach, as indicated in President Johnson's proposal in relation to the possible common endeavor by Europe and the United States in the Jupiter project. This proposal implies the acquisition by European countries of U.S. technology, without charge in the case of Government-owned technology, and through payment in the case of private patents.

The Italian plan is now under study and I understand it will be examined by the Council of Ministers of the NATO countries this December. I fervently hope that this and other means will be devised and implemented so as to assure a two-way flow of technology across the Atlantic, consistent with the vital requirements of a homogeneous development and transformation of the U.S. and European societies.

QUESTIONS FROM THE FLOOR

Professor Chenery: Both of our speakers have referred to the quality of "appropriateness" in the technology to be transferred. I would like to point out that the total capital investment in all underdeveloped countries, comprising nearly a billion and a half people, is less than the total *annual* capital investment in the United States. The need to economize on investment embodying any new technology is obviously enormous. The capital invested per worker in underdeveloped countries is now one tenth or one twentieth of what it is in the United States.

Of course, this does not mean that each industry in an emerging country has to be designed so that it uses only a small proportion of capital, but it does mean that only a very small number of sectors in such economies can be equipped with the capital-intensive technology to which the U.S. and Europe are accustomed.

Let me suggest that we think about the relations among economic sectors. It is probably efficient to have a small number of sectors, even in quite primitive countries, that do have the latest technology, provided they fit into the environment, as Dr. Rahman proposed. Fitting into the environment may mean that the construction industry which builds the buildings might employ completely unautomated means, because that can be done efficiently under these circumstances, whereas the machines which operate in the buildings might be of the latest design.

The advanced countries have to figure out, somehow, how to transfer technology to underdeveloped countries, even though it is not always the same technology which they are using themselves. This problem is probably relatively easy to solve technically, if somebody were willing to finance even a half-billion dollars worth of R&D on designing appropriate technology for India or Pakistan or other countries at that level of development. The principles are known; the trouble is there is no ready way, even though the technology would itself be profitable once it is established. There is not now a mechanism which brings together the resources in the private sector with the users in the private sector. This is the gap which has bothered governments and the economists for a long time. The profitable international transfers are going to take care of only a small part of the problem. Let me invite a few comments on this from the audience before we turn to our formal discussants.

Mr. Wionczek: It may be of interest to this session of the Symposium to know some preliminary results of a study prepared recently by me for the United Nations Secretariat on the subject of the transfer of technology to the developing countries through enterprise-to-enterprise arrangements. This case study dealt explicitly with issues arising in Mexico, a country which, because of its very satisfactory economic performance in the past two decades, is considered today semi-industrialized.

A cursory survey of the local scene discloses that, at the present state of Mexico's industrialization involving implementation of heavy and intermediate industries, technology imported from abroad is of crucial importance. This foreign-originated technology flows not only from foreign private enterprises to private enterprises in Mexico, but also to firms fully owned by the State or with minority public capital participation.

The massive transfer of foreign technology to Mexico and the growing size of payments for these transfers led to the feeling, which is spreading throughout the country, that because of the fact that Mexico cannot afford in the long run to finance the cost of technology acquired abroad through traditional enterprise-to-enterprise channels, some new arrangements in this field will have to be devised. The present debate in Mexico runs along the following general lines:

The country cannot afford to abandon its objective of rapid absorption of new technology and to use "second-hand" know-how because of longer term development considerations—especially the need to diversify exports.

For political reasons, Mexico cannot permit the complete technological domination from abroad through arrangements tying up new technology to private foreign investment exclusively.

Both for political and economic considerations, foreign private capital should plan gradually to withdraw, in agreement with other countries, from industrial activities in which technology is relatively stable or where there is ready access to non-proprietary know-how that may require no more than advisory services to the local capital replacing the foreign-controlled investment;

On the same grounds, foreign capital should contribute to the development of local applied scientific research in areas of dynamic technology;

Moreover, the cost of foreign technology to Mexico must be lowered through external financial assistance and general liberalization of conditions under which technical services and licensing and engineering agreements are negotiated between foreign owners of technology and Mexican private and public enterprises.

The position described above seems to imply many legitimate grievances of a rapidly industrializing society which faces technological power of the more advanced countries and whose dependence upon foreign technology continues to increase.

During my interviews with state officials in charge of industrialization, experts engaged in technological research and executives from industrial enterprises, opinions were heard that a relatively limited relationship exists between the nature of transferred technology and modalities of the transfer itself. The picture which emerges is rather that the problems of transfer are more closely related to the intensity of technological change and the respective size of local firms receiving technology from abroad. Another important element is considered to be the existence or absence of corporate links between the foreign owner and domestic receiver of technology.

Large state-owned or controlled enterprises in Mexico do not seem to face any major problems in respect to acquiring adequate technology from abroad. Larger domestic-owned private corporations in Mexico seem also to show a growing ability to shop for available technology around the world and especially to discern between patented know-how available only through license agreements and non-proprietary technology. Unless the purchases of technical know-how are tied to purchases of capital equipment through medium or long-term export credits, these larger enterprises follow the strategy of diversifying their sources of know-how through entering into separate agreements on designing and construction of production facilities, on technical services covering provision of technical information and on licensing agreements covering patented knowledge. Very often these large enterprises hire international consultants of great prestige for the purpose of feasibility studies and ask them later on to act as advisors on choice of foreign technology and its sources.

The situation is very different and more difficult in the case of small and medium-sized industrial enterprises in Mexico. They face practically only two alternatives: (a) buying packaged technology abroad in the form of a plant which incorporates the design and construction of facilities and patented know-how and technical services; or (b) following the strategy of larger enterprises by negotiating separate agreements with foreign technology owners at different levels. Because in Mexico both the state and private manufacturers of capital goods are unequivocally opposed to importation of packaged plans, a small or medium-sized industrial enterprise finds it very complicated and often very expensive to acquire new technology from abroad. Normally, it finds it necessary to make a single arrangement with a foreign firm having access to all phases of technology required and not available from within the country.

This last choice inexorably leads to corporate links which many small and medium enterprises try to avoid in fear of the undue degree of control by the foreign partner.

These are some of the preliminary findings of my survey. They point out a need to start much broader research on this subject, possibly with participation of experts from both the developed and the developing countries. The U.N. Fiscal and Financial Branch will undertake such pioneering studies in 1967. The issue itself has a high political content and may become within a short time a source of considerable friction between the owners of new technology and the developing countries.

Professor Rey: I am scientific advisor of Nestlé-Alimentana Company of Switzerland. I wish to add to what has been said this morning on the technological gap. I believe that there is not only a technological gap between Europe and the States, but also a technological gap between Europe, the States and the Far East.

Nevertheless, in our own particular case, we have gained a lot by establishing close connection with Japanese companies and with American companies. Besides, we have a subsidiary research establishment in the States, and for that reason have eliminated any technological gap between the European operations and the American operations of the same European company.

As far as Nestlé is concerned, we are involved in manufacturing and sales in more than 100 countries, and we have research establishments in several places in Europe as well as in the States. However, when we are faced with a need for very specialized types of technology, such as when we became interested in radically new sources of food for the future, we went out to find partners who could give us the technology and the know-how in their specialized fields. It was announced last July that Nestlé entered into a joint venture with a company in New Jersey —a typical case where two big companies with common interests in a given field can complement each other's know-how. This, in my opinion, is one of the best kinds of enterprise-to-enterprise agreement; they are non-competitive and complementary.

Dr. M. Kersten: I am the President of the Physikikalisch-Technische Bundesanstalt of Braunschweig, Germany, and I would like to make a remark about the international transfer of technology by national standards institutes. Perhaps my colleagues at the National Bureau of Standards are too modest to speak about it. All these national institutes are increasing their cooperation, especially with the developing countries. Some cooperation has been in effect, as in our case, since the beginning of this century.

I would like also to remark about the role of fundamental measuring devices, as a means to transfer of technology. It is very important at the start of the industrialization of a developing country to provide a modern measurement system and standards, including the newest methods. Sound measurements lead to sound industrial and social life. The national standards institutes must see that education toward this point of view is their common duty. I will add only that collaboration among all the national institutes should be encouraged. The United States, Canada, and the United Kingdom, Germany, and so on are already doing so. This is a vehicle for the transfer of technology which extends way beyond fundamental units and measuring methods.

JOHN H. DESSAUER *is Executive Vice President of the Research and Advanced Engineering Division of Xerox Corporation, and Vice Chairman of the Board of Directors. First joining the research department of Agfa Ansco Company when he came to the United States in 1929, he became associated with the Rectigraph Company in 1935, shortly before it was purchased by the Haloid Company, forerunner of Xerox. He established the research department there, engaged in a search for new products and, together with Joseph C. Wilson, explored the xerographic (electrophotographic) process when it was publicized in 1945. The research effort which Dr. Dessauer now directs for the Xerox Corporation is the outgrowth of the Haloid Company's research established by him in 1938.*

A native of Aschaffenburg, Germany (1905), Dr. Dessauer, after receiving his early education there, went on to the Albertus Magnus University in Freiburg for Liberal Arts studies. He then received the equivalent of a B.S. degree in chemical engineering from the Institute of Technology in Munich, followed by his Masters and Doctors Degrees in engineering sciences at the Institute of Technology in Aachen, Germany; both cum laude.

Professor Chenery: Thank you very much. I think we should now turn to the first of our formal discussants, Dr. John Dessauer, who is Executive Vice President of the Research and Advanced Engineering Division of the Xerox Corporation.

Dr. Dessauer: With your permission, I would like to limit my comments to the experience of Xerox Corporation, since I feel that I must disqualify myself as an expert in this complex situation of technology transfer.

Required Characteristic for Successful Transfer of Technology

Now in our experience, the transfer of technology must have one very important characteristic in order for it to be successful. It must be mutually beneficial. It cannot be like a blood transfusion, where the donor does all of the giving and the receiver gets all of the benefits. It is true that relationships like that *can* exist, and it is also true that most lay people and, in fact, most taxpayers think of technology transfer in those terms.

But, it has been the experience of those of us who work in this field of industry that in order to be viable a relationship must benefit both parties—the transferor and the transferee. Perhaps I can illustrate such a viable, mutually beneficial relationship by telling you how Xerox approached the problem of Technology Transfer through an enterprise-to-enterprise arrangement.

Formation of Rank Xerox Ltd.

In 1956 we formed an affiliated company, Rank Xerox Ltd., with The Rank Organisation of England as our partner. This company was formed to take advantage of our technological development and patent position and also to utilize the assets which The Rank Organisation had to offer. These assets included not only money but also experience in international distribution and services. Xerox invested technology in the form of know-how and patents. The Rank Organisation invested money, international operating management and manufacturing and distribution capabilities. The profits are shared on a 50-50 basis up to a datum point. Beyond this, Xerox Corporation receives two-thirds of the profit. The datum point can be changed according to the capital invested by Rank. Based on this agreement, Xerox Corporation does all research and development work and transfers the results, subject to all U.S. regulations, to the British-affiliated company.

The British Rank Xerox, in turn, followed this same pattern and set up a Japanese company jointly owned with Fuji Photo Film under the name of Fuji Xerox.

Mechanics of Technology Transfer

During the ten years following 1956, Xerox transferred the technology it applied to the development, design and manufacture of such machines as the Copyflo, the 914 and 813 copiers and the 2400 copier/duplicator.

This transfer was accomplished in the form of engineering drawings of parts and assemblies, manufacturing fabrication and assembly process instructions, consumable material formulations and specifications as well as product service procedures to be used by the technical sales forces. We are fortunate that, in our field, the same products identified for our national U.S. market have to date qualified for international usage, and we foresee that this will continue. In the past, a certain amount of adaptation (Anglicize and Nipponize) for English and Japanese requirements had to be accomplished. With new products on the drawing boards at the first stages of development now, we are trying to come up with a design which will fit the world-wide requirements. This is accomplished by giving our British and Japanese associates a voice in the selection and specification-writing of new programs as well as having representatives of the affiliated companies as part of the technical development and design teams in Rochester when we get under way.

Our experience has been a most happy one. The only serious problems have arisen from the need for more international standards, since Japanese System is based on the "CGS" system, and we here use the inch and ounce approach.

Perhaps the best way to confirm my claim for a very successful experience of technology transfer would be to state a few figures.

Results of Technology Transfer

Rank Xerox Limited has grown from 1956 to the present, to a company with manufacturing plants in three locations in England, one in Holland and, through the affiliated Fuji Xerox, with three plants in Tokyo. It has developed distribution and service facilities in 20 countries and territories, and the annual growth for the fiscal year ending in June 1966 has reached the 124 million dollar level. This made Rank Xerox one of the hundred largest companies in Europe in less than 10 years.

By comparison, Xerox Corporation's sales have grown during this same period from 24 million dollars to over 393 million dollars last year and to an annual rate of over 500 million dollars this year.

You may recall that I started out by saying that for a transfer-of-technology relationship to be successful, it must be mutually beneficial. The above figures give evidence of the fact that this has been just such a relationship.

Professor Chenery: Whether by accident or design in the programming, all three of our formal discussants have transferred technology from Europe to the United States. Our last two are both Dutch-born U. S. residents. Dr. Soutendijk, who will comment now, is Manager of Brown Bros. Harriman and Company.

Dr. Soutendijk: Not having a company with experience in the field of technology to discuss, I hope that you will permit me to make some general remarks about the technological gap between Europe and the United States. I want to limit these remarks to some economic and financial points which might contribute to a discussion later.

Nature of the U.S.—Europe Gap

I have been trying to find out for myself why there is a gap and what kind of circumstances in the economic and financial field have contributed to this gap. Like Mr. Peterson this morning, I came to the conclusion that technology is done by the large companies. We have figures from the International Chamber of Commerce, according to which 60 to 90 percent of all the research is done by large firms. For Holland some rather typical figures have been developed—80 percent of the research is done by companies with more than 1000 employees, and 65 percent of this 80—or 52 percent of the total—is even done by five large companies.

Concentration of R & D in Large Firms and Large Countries

This brings us immediately to the point of concentration. Concentration of businesses we see in Europe at the moment, on a large scale in many countries. It is stimulated—in the first place—by the Common Market and—in the second place—by the governments of different countries.

We all know the case of France, where it is government policy to stimulate concentration. We have seen a report about it from the German Government. We have seen a similar "White Paper" from the Dutch Government and another from the Common Market Commission.*

This concentration in Europe is in full swing and will, after some time, show results as far as technology is concerned. I have to make the restriction that so far it is only done on a national basis. We don't see concentration of businesses in different countries as yet, and so there is still much to be desired. But it is a step in the right direction, hopefully leading to a smaller "Imbalance of Technology" between the United States and Europe.

Need for Larger Markets

The next thing that is needed in Europe is larger markets. Here, something is being done already. The duties in the Common Market and the duties between the EFTA countries have been brought down to a large extent, but there are still other barriers, as the negotiators in Geneva, for the Kennedy Round, have experienced.

Although some measures have been taken, there is still a long way to go before Europe will be as large a market as the United States is.

Need for Capital

Another point is that there is capital required. In order to acquire the technology which the United States has, Europe can buy it or it can develop technology itself. Developing it is ordinarily more expensive than buying. Also, you don't have the risk of mistakes when you buy it, and it is probably a simpler way, but it requires capital.

Here we come to the strange phenomenon that in Europe there is enough savings—we have seen before the Interest Equalization Tax that most of the European issues floated in New York were bought by European capital. We have also seen, as reported in a recent publication of the Atlantic Institute in Paris, that there is a remarkable balance in amounts invested by Europe in the United States as compared to the amounts invested by the United States in Europe. But there is a difference in composition; European investments in the United States are most-

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L. R. W. SOUTENDIJK *is Manager of Brown Brothers Harriman & Company, commercial banking, investment counsel and brokerage firm of New York. From 1946 to 1959 he served as Financial Counselor to the Netherlands Embassy in Washington.*

Dr. Soutendijk was educated at the Rotterdam School of Economics, from which he received his Doctorate in Economics.

Dr. Soutendijk is currently President of the Netherlands Chamber of Commerce in the United States and Vice President of the Netherland-America Foundation. He has served as a member of the Netherlands Delegations to the Reparations Conference in Paris in 1945 and to the inaugural meeting of the International Bank for Reconstruction and Development and the International Monetary Fund in Savannah, Georgia in 1946. In 1945 and 1946 he was Secretary, Economic and Financial Division of the Netherlands Military Mission. He was alternate Executive Director of the International Bank for Reconstruction and Development during the period 1952 to 1954.

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ly portfolio investments; American investments in Europe are mostly direct investments, bringing ideas, techniques and processes to Europe. So even when there are sufficient savings in Europe these are not directed to improve technology.

Need for More Coordinated Capital Markets

This brings me to capital markets. The study of the Atlantic Institute mentioned that there are a number of shortcomings as far as the capital markets in Europe is concerned; of these the separation of the different national capital markets is a most important one.

We should have—there should be—a European capital market, and to promote this there should be a harmonization of law and taxes in general. The Common Market Commission is moving in this direction but, also here, there still is a long way to go.

There is a kind of transfer of know-how in connection with capital markets, and I might point out that the World Bank has for years been trying to assist in the development of capital markets in the developing countries. I might also point out in this respect that American banks have been going and are still going to establish themselves in Europe, in one form or another; this definitely will contribute to the foundation of capital markets over there. And in the third place I want to mention that a large American chemical company has taken an interest in a Dutch bank, a couple of years ago, in order to participate in the European money market, and has recently established a bank in Zurich to be active in the European capital market. So there is some transfer of know-how in the field of capital markets.

Old Attitudes About Exports of Technology & Capital

I would like to touch on the attitude which the different countries can take with regard to international investments. We have not too long ago, and I think it was Mr. Cooper who mentioned it yesterday, seen that there was a time that countries didn't want to export capital, they didn't want to export technology. A very interesting article in the Federal Reserve Bulletin in 1950 quoted a German publication of 1907, under the title, "Is Export of Machinery Economic Suicide"?

When we look at the United States as the major country that is supplying technology, we can state that here there is no concern in this respect whatsoever. The United States never has had any objection against these exports and the United States doesn't have to. The article in the Federal Reserve publication gives as explanation the composition of the United States exports, which are not endangered by industrialization since U.S. export articles are geared to increase production or are required by an expanding consumption. And the same goes for the industrial raw materials exported by the United States. In this connection we should remember the well-known fact that industrial countries are usually each others' best customers.

This brings me to the attitude which the receiving countries have towards foreign investments. We have seen some remarkable changes. We have seen for instance, the French government opening an office in Paris in 1959 to attract American investments and closing this office in 1964. France is now more interested in exporting capital to the United States than in attracting capital to France, except when it is connected with technology, with the transfer of technology, or with research in France itself.

In view of the late hour, I shall limit my remarks to this. Maybe we will have an opportunity to come back to these issues in the future.

Professor Chenery: The third discussant is both a scientist and a manager of a technology-based enterprise. Dr. Knoppers is President of Merck, Sharp and Dohme International.

Dr. Knoppers: As a closing speaker I am in a somewhat difficult position because everything that I wanted to say has been said, and—even worse—it has been said better than I could do it.

The Key Element: Superior Management

I am very grateful that I had three industrial speakers before me who stressed the point which has been made to this conference since the opening remarks of Secretary Connor until now. We see clearly again that their three companies were successful because they had superior management which created the technology they wanted, and this inter-action between management and technology, with its feedback, is essential for technological progress.

The story of Merck in this field started in the early 30's. The late Mr. George Merck, president of the firm, was dissatisfied with the progress of pharmaceutical developments. The industry couldn't attract the right people of imagination and capability, so he made a management decision. He asked the advice of some of his friends outside the industry. This was something which Mr. Petersen alluded to this morning when he talked about cross-fertilization. A modern industrial manager must understand other fields of life: government, economics and science. Mr. Merck consulted several outstanding scientists and he spoke to presidents of universities. And as a management decision, again, his company created laboratories in which basic research was combined with objective, directed research with a broad latitude of freedom. The tradition of Mr. Merck has been followed up and expanded by his successors, and I think this approach is the real source of the success of innovation in drugs by an American company.

Indeed, I believe deeply that the broadening of the attitude of management towards technological development is essential. And I can possibly feel it a little more acutely because I'm a product of two worlds, one in which interplay between industry and science is utilized fruitfully and an older world where this is less often true. Yet I think we would do well to ask ourselves where the basic differences in attitudes lie.

Willingness to Exchange Experiences

The first difference is that American management stimulates a freer exchange of experiences, and a freer exchange of experiences means competition. If you hear how others do it and how well they do it, you want to do it as well, or better.

Looking for Uses for Scientific Findings

The second difference, I think, is that in the United States the drive of management to find applications for basic findings is fierce—I sometimes call it ferocious. It's the habit of thinking immediately and eagerly: "What can I do with basic findings? What basic needs can I fill with them?" In my own field, the pharmaceutical field, the British biologists and pharmacologists had a complete lead in the physiology of nerve transmission, a very essential part of physiology, with great clinical implications. But it became such an obsession in many of their universities they forgot to develop a satisfactory number of application-minded pharmacologists.

Providing Management Talent in Depth

The third difference in my opinion is that, except on the higher level, the level of Dr. Peccei and others in Europe, there is a management gap. In the United States there are many more good research directors, both in the giant companies and among smaller competitors. And, I think, here is a challenge for Europe to improve its performance. I think that from the management point-of-view, Europeans generally should give more attention to application and they should really try to develop better professional long-range planning, both in function and the development of people. One application of this attitude was referred to this morning by Mr. Peterson, when he spoke about those small companies, the entrepreneurs, that come up and really are pioneers for the big companies. The leaders must keep completely awake because they could be overtaken at any time by competitors with new concepts.

ANTONIE T. KNOPPERS *is President of Merck, Sharp & Dohme International, a world wide manufacturer of pharmaceuticals and chemicals. From 1950 to 1952 he was Professor of Pharmacology at the Free University of Amsterdam, following which he was appointed Manager of Medical Services in the international operations of Merck and then Director of Medical Services for Merck, Sharp & Dohme International. He became Director of Scientific Activities for that division in 1955 and the same year assumed the Vice Presidency and General Management. He assumed his present position in 1957.*

A native of the Netherlands and now a citizen of the United States, Dr. Knoppers received his Doctor of Medicine degree from the University of Amsterdam and his Doctor of Pharmacology from the University of Leyden.

Dr. Knoppers has authored some 60 scientific papers in the fields of pharmacology and endocrinology.

Rewards for the Entrepreneurs

I think that Europe could improve its performance with better tax laws. We complain about the tax laws for our entrepreneurs. But in some European countries, if an entrepreneur would put his capital to risk and make a million dollars, he would lose virtually all in taxes, then or later. For instance, Great Britain has not followed through with research and development although it has had the initiative in many technological basic ideas—vertical aircraft, to mention one example. A country that does not reward its entrepreneurs—entrepreneurs that dare to take risks—is in trouble technologically.

Using a Technological Advantage on a World-Wide Basis

And another possibility is the one that Dr. Peccei mentioned. This is the role, the "world-wide" attitude, of firms such as IBM, Olivetti, Xerox, Merck —I mention only those who stand here on the platform. They establish themselves everywhere. Theirs is an example of a management attitude that remains enormously important. I would venture a suggestion: in the pharmaceutical field our main competitors are three or four big firms based in Switzerland, a small country. So the question of home-country size doesn't play a crucial role, if the company specializes, invests and reinvests in research and above all has a world-wide approach.

The Positive Values of a Technological Gap

I feel that basically it is in the interest of the United States that we maintain a technological advantage: that we transfer more technology out than we take in. This protects the balance of payments and contributes to the balance of trade. Through payments made for licenses and royalties, and through exports of technologically advanced products, a vital contribution is made.

Therefore, I feel that the technology-based American companies should be good traders; they should really use their technology to earn money for this country.

Although I'm thoroughly prepared to be sympathetic with the general aims of the Italian (Fanfani) plan, especially since it recognizes the need for better technology, I would be very much against weakening our attitude to the exploitation of technology without sound payment. I'm simply surprised at the suggestion that United States government research and government technology should be given freely to Europe at the moment we are in some difficulties with the balance of payments. To give away the taxpayers' money—as represented in the value of government patents—to European countries which are affluent, would, I think, be the opposite of wisdom.

While I consider it useful, on the one hand, that there is a gap, I am convinced that the gap must remain manageable (and there I am very sympathetic to the ideas of Dr. Peccei). Should the gap become unmanageable, it could lead to a chain reaction of undesirable consequences. It could make technology too expensive for Europe to buy; it could create protectionism, and it could encourage curtailing of direct investment—all of which runs counter to our nation's need, which is a Europe where we can sell to an affluent, sophisticated society. And it would be against the interest of Western Europe itself, as it is a move backwards. But, as I said, I don't think we have reached this unmanageable stage yet, and Europe has been alerted.

Technology for the Developing Countries: Can We Help?

I see the problem of technology in less developed countries in a different way. It is quite clear to me, especially after what we heard from Professor Rao and Dr. Rahman, that this problem is not solvable with the present means. Still, we have it in our hands, I think, through technology, to solve problems of underdeveloped countries; the methods to apply this technology with maximum effectiveness are yet to be found. A very broad systems approach could be the theoretical solution. But political and emotional problems within less developed countries hamper the implementation. It is a problem of major magnitude!

Dr. Seitz yesterday referred to man in terms of his evolution as a user of tools: *homo faber*. It seems that we face some difficulties in finding out how we can use our present tools—not only in the problems less developed countries have, such as population control, food supply, et cetera, but with our own problems as well (air pollution, slums et cetera). We have to ask ourselves whether man is equipped in the evolutionary process to handle those tools with wisdom. It means, negatively, can we control our emotions, can we harness our aggressions and territorial compulsions? Positively, will we men be wise?

In other words is this technical man a *homo sapiens?* That's possibly the question.

Professor Chenery: Thank you, we now conclude this part of the Symposium.

CLOSING REMARKS

Secretary Connor: What has happened here in these two days indicates the complexity of the relation between technology and international trade, the complexity of the problems attendant upon the transfer of technology from one country to another, from one industry to another, from one company to another, from one government institution to another.

Our friends on the platform and in the audience have delineated some of these problems, particularly as applied to the transfer of technology from developed nations to underdeveloped nations. We now have to break down the general problem into its various component parts. The problems attendant upon the transfer of technology from an agency of the United States Government to a private firm in Mexico are obviously different from the problems that are associated with the transfer of technology from Olivetti, in Italy, to Olivetti-Underwood in the United States. The reverse follows. It is also different in a situation involving a private firm in the United States with a competing firm in Great Britain.

The problem of competition needs to be stressed somewhat more than it was during the formal program. In our system, after developing new technology using stockholder money, it just isn't feasible for a corporation to give that away without adequate consideration. The adequacy of the consideration can vary from case to case, but there must be some return on the technology that represents an investment of stockholders' money. Then, the point made about the transfer of technology developed in the public domain, involves quite a few special problems. Most of that technology gets into the literature and is available to the public on a worldwide basis. However, the actual transfer of the know-how involved requires additional expense for travel of skilled people, for example; this additional cost might have to be justified to the Appropriations Committees, as one example.

This symposium, in many respects, has been an eye-opener, certainly for me and perhaps for some of you. For one thing, I have a completely broadened view of the question of the "technological gap." The fact that so many people have talked about the differences in the managerial competences, attitudes and techniques is of considerable importance. We are left with the conclusion that an important element in the so-called technological gap consists of what could be called a managerial gap, and this is surely something that would have to be given more attention in the future. In the discussion this afternoon, we get on the question of the gap in capital resources; in any further consideration of this problem, this element has to be explored in greater detail than it has heretofore.

In thinking about what has transpired, I come up with an analogy. It seems to me that we can view technology as a vehicle of progress, with managerial skills in the driver's seat, incentives as the fuel, and the road paved with capital resources. These are certainly the important elements and make me come back with renewed emphasis to the importance of the management factor. If the *management* of technology is as important as stated in this two-day session, then we should take definite steps in all the countries to do something about the lack of trained, highly motivated people with managerial skills, who are willing to try to make technology work for the benefit of mankind. That is the final thought that I would like to leave with you, because that is really the objective of our endeavors—to improve the condition of mankind. Thank you all, very much.

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