Proceedings of the International Conference on Science and Technology Policy for the Developing Countries

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International Conference on Science Policy for Developing Countries

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WELCOME ADDRESS – INTERNATIONAL CONFERENCE ON SCIENCE POLICY IN DEVELOPING COUNTRIES
Manila, July 14, 1988

Paulo C. Campos
President
National Academy of Science and Technology

Dr. Antonio Arizabal, Professor Sharma, Professor Radnakrishna, Distinguished Guests, Colleague in the Science Community, Fellow Academicians, Ladies and Gentlemen.

Today, we are witnessing widening gaps in the economic development of countries around the world. While a few countries, mostly of the West, are enjoying relative affluence, the greater number of people from Asia and Africa are still economically underdeveloped. The last decade or two has witnessed rapid economic development of a few countries around us, some of them equally devastated by the war. A number of factors obviously contributed to this almost miraculous developments but a common thread seem to play a significant role in all these emerging industrialized countries and that is the role of science and technology.

We are gathered today to share experiences and views on how our respective countries utilize science and technology so that we can maximize its contribution to our economic development.

We are of course, aware of the differences and the problems in each of our countries. Some countries may abound in natural resources while others may bank more heavily on human resource. Some of us would rather maintain a self sufficient economy; while others would rather lean on an export-oriented one. These difference may require distinctive policy requirements but the sharing of experience and know-how will always be beneficial.

In this note, permit me as President of the National Academy of Science and Technology (NAST) of this country to welcome you all.

I thank you.

INTRODUCTION OF DR. ANTONIO V. ARIZABAL

Melecio S. Magno
Vice President
National Academy of Science and Technology, Philippines

Our guest speaker today is a simple and a top-notch scholar who was born in Manila on October 30, 1932. He graduated "cum laude" from the University of the Philippines as Bachelor of Science in Chemistry. He obtained his Master of Science degree in metallurgical engineering, first place, from the Carnegie Institute of Technology, Pittsburg, Pennsylvania in 1957 and a Ph.D in metallurgical engineering from the same institute in 1961.

He has been a consistent scholar and an awardee. He was one of the Ten Outstanding Young Men of the Philippines in 1966, representing the field of iron and steel technology.

Our guest speaker has written several volumes on the subject of metal industries such as the refractory industry, the non-ferrous industry, the casting industry, coal industry and primary iron and steel industry. He has also presented and read various scientific papers in local as well as international science conferences notably among which were:

1) Vapor pressure of SiO_2 and Thermodynamic Activities of the components of CaO-SiO_2 Melts;
2) Automated Blast Furnace Control;
3) Selection of Iron and Steel Making Processes Applicable to Philippine Conditions;
4) Modernization in Transportation and Communications for ASEAN Economic Growth; and
5) The Technological and Metal Infrastructure: Imperatives for Technology Transfer.

Our guest speaker has also been an internationalists, consultant and a negotiator. As an expert on iron and steel, he has represented the Philippine government and in negotiations for the (US$63.3M) Iligan Integrated Steel Mill project from the Ex-Im Bank, Washington, D.C., for the (US$35M) Sta. Inez Steel Project from Kreditanstalt fur Wiederaufbau of Frankfurt, Germany and the UNDP/ UNIDO Technical Assistance Grant of US$2.7 M to MIRDC.

Inspite of full time work and hectic consultancy services, he has managed to maintain connections with educational institutions and learned science societies or associations, either as professorial lecturer, active member or director of the board of trustees. Since graduation he has held top positions in private firms or government agencies. It is no surprise then that President Aquino appointed him

Secretary of the Department of Science and Technology when she assumed presidency and formed her cabinet.

Ladies and gentlemen, it is an honor and a privilege to introduce Dr. Antonio V. Arizabal, Secretary of Science and Technology.

KEYNOTE ADDRESS

Antonio V. Arizabal
Secretary
Department of Science and Technology

Prof. A.K Sharma, President, Federation of Asian Scientific Academies and Societies, Dr. Paulo Campos, President of the National Academy of Science and Technology, Distinguished Academicians and Speakers, Honored Guests, Friends in the Science Community, Fellow Guests, Ladies and Gentlemen:

It is increasingly being realized nowadays that science and technology represent the most significant factor in accelerating socio-economic progress. The emergence of the newly industrialized countries of Asia is a testimony to the fact that a nation's rate of economic growth leans heavily on its technological capacity. Through the infusion and mastery of science and technology, countries like Korea, Singapore, Taiwan and HongKong have registered a growth rate in Gross National Product of 10% or more per annum on a sustained basis.

Economic policy planning that fails to include the appropriate technological dimensions are no longer considered good enough to optimally deal with the problems of national development. It is for this reason that science and technology has assumed a major role in the developmental plans and strategies of the most progressive nations. The technological handicap of the developing countries is said to be primarily due to lack of planned attention towards the formation of an effective scientific and technological infrastructure. This brings to the fore the importance of sound science and technology policies.

Science policy represents the collective measures taken by a government to promote scientific and technology programs and activities essential to national progress. Such policy involves programs on research and development, education and training and technical services. It has also to be directed towards exploiting the results of such activities for the public benefit. Science policy is a projected program of goal, values and practices. Thus, the formulation of science policy involves such issues as how much resources should go to science and technology considering the competing claims of other government functions on national resources. Within science and technology, how should financial and manpower resources be divided among areas considered vital to national advancement? How many scientists and engineers should be trained? What institution and facilities should government provide them with? What scientific and technical services should be made available? What government machinery is required to answer such questions about science and what technical sophistication is needed by public servants who have to answer them? Indeed, developing countries such as those represented here need to exert vigorous and renewed efforts to obtain the correct answers to these questions.

I wish to share with you today a broad picture of our policy for developing and applying science and technology in the Philippines.

The strategic role that science and technology play in national development is well recognized, as already mentioned. For the first time, the new Philippine constitution has enunciated a state policy for science and technology (S & T). The 1987 Constitution so declares that the state shall give priority to research and development, training and services and, shall support indigenous, appropirate and self-reliant S & T capabilities and their application to the country's productive systems and national life.

We are in the process of updating our 1987-1992 medium-term Philippine Development Plan where one component is science and technology. Our science planners' vision is to attain industrialized status by the year 2000. We are developing a national infrastructure for advanced science and technology to carry the nation into the 21st century. Last year, the Philippine Council for Advanced Science and Technology Research and Development was established. This agency is to spearhead activities in the advanced science and technology areas. Emerging technologies which are directly relevant to the socio-economic conditions prevailing in the country shall be adopted so that the country is able to leapfrog in technological advancement thereby improving the country's economic posture in the 21st century. Recent developments in microelectronics, biotechnology, materials science, and new energy sources, among others, shall be harnessed to upgrade agriculture, industry and the essential services. The utilization of advanced technologies shall be blended and integrated with traditional technologies to preserve the environment and the health of people. Science and technology shall be harnessed to support the employment-oriented and balanced agro-industrial development strategy.

We have adopted the policy that a larger fraction of our financial and manpower resources shall be devoted to commercialization endeavors. The intention is to accelerate the commercial utilization of technologies that have accumulated at the laboratory bench-scale level.

Without totally neglecting basic research, greater emphasis shall be given to short gestation projects, namely those involving pilot testing or precommercial development of research results. Following the demand-pull-strategy, these efforts shall address the urgent technological requirements of the economic recovery program and other concerns such as the provision of livelihood and employment opportunities leading to the attainment of a greater degree of national self-reliance.

Consistent with the national policy of increasing private sector participation in development efforts, we are proposing science and technology incentives legislation which shall provide various forms of fiscal incentives and special research and development loans to firms engaged in research and development. This would boost private sector R & D from a present level of 15% to about 40/50% by 1992. With increased researches, the base for the development of technological innovations shall be expanded leading to improved product quality and increased productivity. Furthermore, commercial application of research and development results to modernize industry, agriculture, and social services shall be accelerated.

Our science policy also directs attention not only to the effective management of technology but the mitigation of the deleterious effects of natural and environmental hazards as well. The environmental impact of technology shall be of prime consideration in its development and utilization. The application of technologies should not in any case, impair the quality of the environment and R & D efforts on various aspects of environmental degradation, shall be intensified.

Our planning priorities reflect a policy of establishing a balanced and cost effective technological system ranging from the simple to the advanced. We look forward to a wide range of technologies from low cost low-input technologies such as the production of drugs from indigenous sources, to the applications of laser technology, and molecular biology.

Science and technology indeed hold the vast potential to overcome the all-pervasive that characterizes underdevelopment. To sustain a sound economy, the government should adopt policies supportive of technological innovation essential to national development.

In conclusion, I hope that the interaction and sharing of experiences resulting from this conference would continue to foster collaboration in the study and successful implementation of science and technology policy for the socio-economic well-being of the developing countries.

THE ROLE OF SCIENCE AND TECHNOLOGY IN THE INDUSTRIALIZATION OF KOREA

Hoagy Kim
Chemical Research Coordinator
Ministry of Science and Technology
Republic of Korea

It is a pleasure and honor for me to take part in this international conference and to talk about the role of science and technology in the industrialization of Korea. Before getting into my subject, I should like to express my gratitude to Dr. Campos and the National Academy of Science and Technology of the Philippines for kindly inviting me to the conference. I am sure that this conference will provide us with an invaluable opportunity to learn from one another's experiences how a developing country could improve its economy by advancing science and technology.

Korea seems to be attracting considerable attention from the world these days, largely for its rapid economic development and more immediately for the upcoming Olympic Games. However, the fact that science and technology has played an important role in the national development during the recent years is probably not as well recognized. Korea has a rich scientific heritage as manifested by the ancient astronomical observatory of the Shilla Dynasty and the first movable metal print in history invented two centuries before Gutenberg. However, such scientific talent has seldom been efficiently utilized for industrialization throughout Korea's long history for various historical, socio-economical, and philosophical reasons.

It was in 1962 when science and technology in Korea began to see the new light as a driving force for national industrialization with the launch of the first Five-Year Economic Development Plan, which is generally considered as the first organized efforts to manage our national economic affairs.

Korea was then one of the poorest countries in the world still suffering from the devastation of the Korean War, and industrialization seemed to be a far-fetched idea because the most pressing need was to satisfy the basic needs of the nation. Indeed, the government's decision to seek national economic development by industrialization faced violent opposition from many people at home and abroad, on the grounds of impracticality or difficulty in resource allocation.

One may assert that the development of a nation neither starts nor ends with economic expansion alone, but I believe that the strategy of maximizing the growth potential has worked out well, and that our country has become a much better place to live in after the successful implementation of a series of Five-Year Economic Plans.

Today, I will discuss the development policies and strategies of science and technology during the past quarter of a century and outline present and future policy directions. Our strategies for scientific and technological developments have been hitherto closely associated with our economic plans, and I will outline them in three distinct stages, namely the 60's, the 70's and the 80's.

During the 60's the main objective for the industrial development was to lay a foundation for industrialization through the development of import-substitute industries, expansion of light industries, and support for producer goods industries.

In this early stage of industrialization, the Government emphasized the scientific and technological strategies focused on accelerated introduction of foreign technologies, and build-up of domestic technological infrastructures. During this period, the Ministry of Science and Technology was established as the Central policy-making, planning, coordinating, and promotional body in the government. The Korea Institute of Science and Technology (KIST), a comprehensive industrial technology research institute, was inaugurated in 1966, for the stimulation of domestic R & D activities as a basic approach in the area of science and technology to achieve its development goals.

KIST was established to bolster the industrial sector, particularly in those areas emphasized in the national economic development plan, and to eliminate the bottlenecks hindering further growth. Special legislation was enacted to make this institute a contract research agency so that marketing principles would prevail in the realm of R & D.

In the 1970's, the following three major strategies were adopted: 1) higher manpower development to meet the needs of the heavy and chemical industries; 2) improvement of the institutional mechanism for adapting imported technology; 3) and promotion of R & D activities for industrial applications.

To meet the industry's needs for manpower able to handle high-level technologies, the Korean Government decided to establish a new institute for post-graduate scientific education, the Korea Advanced Institute of Science (KAIS). KAIS was designated to provide post-graduate programs in selected applied science and engineering fields as an autonomous institution supported by the Ministry of Science and Technology. Since its inception in 1970, KAIS has awarded almost 5,000 master's degrees and 500 Ph.D's. These degree holders are now playing a very important role in industry, academe, government agencies, and research organizations. Today, KAIS is receiving world-wide acclaim for its academic excellence.

The emergence of the Ministry of Science and Technology spearheaded the enactment of several very important laws for the development of science and technology.

These include: (a) the Science and Technology Advancement Law of 1967, which outlines the basic commitment of the government to support science and technology and to provide policy leadership; (b) the 1972 Law for the Promotion of Industrial Technology Development to provide, among other things, fiscal and financial incentives to private industries for technological development; (c) the Engineering Services Promotion Law of 1973 to support local engineering firms by assuring markets on the one hand and performance standards on the other: (d) the National Technical Qualification Law of 1973 which, through an examination and certification system, promotes an enhancement of status for professionals, in technical fields, particularly for those with practical skills; (e) the Assistance Law for Designated Research Organizations of 1973 which provides legal, financial and fiscal incentives for research institutes in specialized fields from government and private industries such as ship-building, electronics, telecommunications, chemicals, mechanical and materials engineering, and energy and related areas; and (f) the Law for the Korea Science and Engineering Foundation of 1976 which provides a legal basis for the establishment of the foundation as the prime agent for strengthening research in the basic and applied sciences, as well as in engineering, to facilitate more rapid applications of science and engineering to national needs.

The Ministry of Science and Technology is in charge of formulating and implementing plans for the development of science and technology as an integral part of the nation's Five-Year Economic Development Plans.

Since the mid-1970's not only has the size of the Korean economy sustained high growth rate but the industrial structure has been modernized with substantial expansion of the manufacturing sector. Such favorable economic development was possible when Korea had high competitiveness in labor costs, and protectionism and trade barriers of the advanced countries did not pose serious problems to Korea. Furthermore, the shift of the Korean industry in its character from labor-intensive to technology-oriented is requiring more sophisticated technologies which are increasingly difficult to import from advanced countries.

The Korean economy has recorded a marked success of "catching three rabbits at a time," that is to say, high growth rate, low inflation, and surplus in trade balance since 1986, thanks to so-called three-low's, low exchange rate, low interest rates of foreign loans, and low price of imported oil. It seems that advanced countries are overreacting to this and Korea is facing new challenges of obtaining international competitiveness through more intensive R & D efforts in science and technology.

Under these circumstances, the Korean Government has been implementing the following policies to develop science and technology.

The Government will continuously pursue technology-led policy, which allows science and technology to play a leading role in promoting socio-economic development.

Science and technology will accordingly take places of high priority for investment. Consistency and comprehensiveness from the viewpoint of scientific and technological innovation will be stressed in the decision-making processes for the creation of the social environment where professions of scientists and technicians are highly regarded.

Scientific and Technological Advisory Committee, consisting of experts from industrial, academic and scientific milieux will be established in accordance with Article 127 of the new Constitution of the Sixth Republic to recommend scientific and technological policies to the President.

The Government has placed a special emphasis on securing and nurturing of cadres of creative scientists and high caliber technological manpower in order to meet the rapidly increasing demand for R & D, both in the public and private sectors.

As of 1987, the total number of qualified scientists and engineers stood at 54,000, representing 13 persons per 10,000, showing that Korea is still short of high-caliber manpower. To reduce this shortage, the Government, together with the private sector, will pursue the realization of effective training in science and technology-related fields in higher education.

In accordance with the long-term forecasting of high-level scientific and technological manpower requirements, we will secure a total of 150,000 scientists and engineers, or 30 persons per 10,000 by the year 2001. Among them, 15,000, or 10% will be tapped as the top level scientists capable of carrying out the leading role in their respective fields. The Korean Government will reinforce higher science and engineering education, expand overseas training programs for advanced study, and encourage the return of Korean scientists and engineers abroad.

The Government has drastically increased R & D investments since 1980 which contributed to remarkable achievements in science and technology. The budget for science and technology has been increased at a rate of approximately 15% per annum over the past six years, while public enterprises are encouraged to set aside a sizable portion of their income for technological development.

The private sector has also rapidly augmented their R & D investment by about 60% annually, helped in large part by various government incentive programs. As a result, the total amount of R & D expenditure jumped from $557 million in 1981, or 0.9% of GNP, to $1.1 billion in 1986, or 1.99% of GNP.

With a view to our developing science and technology to the level of other advanced countries by the turn of the century, the Ministry of Science and Technology set the goal of boosting R & D investment to 3% of GNP by 1991, and to over 5% in the year 2001.

The Korean Government has undertaken national R & D projects since 1982 to develop key industrial technologies in priority areas. The selection of our national projects is based on whether they are: (a) technology-intensive; (b) competitive internationally; (c) energy conserving; (d) providing growth potential and; (e) contributing to our social development.

The national R & D projects have been carried out by the efficient management of the Ministry of Science and Technology and have greatly contributed to the national development by enhancing international competitiveness and strengthening the base for scientific technological innovation through the concerted actions among the industry, academia, and government supported research institutions.

The Korean Government is encouraging R & D efforts by the private enterprises by providing them with various incentives.

In the case of proprietary technology, the Government makes available indirect incentives to the private sector under the principle of competition. Meanwhile, as for generic technology, the Government extends direct as well as indirect support for the private and public sectors under the principle of cooperation.

Following these two basic principles, the Government recommends large scale companies to establish at least one research center per company, while small and medium companies are encouraged to organize research and development consortiums in related fields. These incentives include: tax exemptions, special allowances for depreciation, financial grants, long-term development loans at low interest rates, and preferential procurement by the government.

As a result of such an incentive system, we have witnessed a remarkable increase in the number of private research institutes from 52 in 1980 to 503 in April, 1988, and of research consortium from none to 37 in the same period.

Korea has also strengthened international technical cooperation in order to meet the rising tide of internationalization of technological development.

To better cope with the growing interdependence of the world economy, Korea has been expanding both bilateral and multilateral international cooperative activities, especially since 1980.

As of the end of 1987, the Korean Government has exchange scientific and technical cooperation agreements with 59 countries and holds annual Ministerial meetings with 10 countries.

Furthermore, 69 international joint research projects have been in full swing with financial support from the Government amounting to $4 million in 1988.

In the spirit of mutual benefit and complement, the Government will make continuous efforts to develop international cooperation through the exchange of researchers and technical information, and active participation in international cooperative programs and joint R & D projects.

We sincerely desire to expand technical assistance to developing countries to share our experiences and technologies for our common prosperity. Programs for technical training and dispatching experts to developing countries have been established for this purpose.

The regional dispersion of technological development is regarded as one of our major policy directions.

The Government has established industrial complexes in major regions of the country since the 1970's, while actively promoting the construction of Daeduk Science Town along with new technology-based industries in the vicinity.

The Government also plans to construct other specialized research parks in the major industrial areas through-out Korea, forming a network with Daeduk Science Town as the core.

The creation of a climate favorable to the development of science and technology has been a major policy goal for laying a solid foundation for science and technology.

Korea has launched a movement for the popularization of science and technology as an integral part of its long range science and technology development plan. The movement aims to motivate a universal desire for scientific innovation among all the people in all aspects of their lives.

The Government also plans to put a new dimension to the movement designed to enhance the ability of the people to adapt to a modern industrialized society.

I have outlined the development policies and strategies of science and technology in Korea during the past three decades.

In striving toward its national development goals, Korea has recorded substantial achievement, completely escaping from the vicious cycle of under-development of the fifties. Through a series of trials and errors, Korea has succeeded in providing qualified technical manpower, in improving national scientific and technical capabilities, in innovating administration and support system, and in increasing as well as focusing on R & D investment. These total science and technology efforts were intended to effect a structural change in the economy from a simple labor-intensive to a more technology-intensive structure, and later to the development of a brain-intensive structure. In other words, Korea's efforts have been directed toward accelerating the transition of the role of science and technology from one of supporting national economic development to one of directing this development toward the establishment of a technologically self-reliant society.

In retrospect, these policy directions led each of the past three decades to the following distinct landmarks: the sixties being the start-up period with the creation of KIST and MOST; the seventies being the era for implantation of technological infrastructures with the creation of government-supported research institutions in specialized fields; and the eighties being the era for the expansion of the R & D activities with the establishment of the national R & D projects and the creation of private research centres.

Against these background, the future policy directions should emphasize balanced developments, namely a balance between basic and applied researches, a balance between direct and indirect implications of policy guidelines, a balance between R & D efforts made by different scientific milieux, etc. The role of science and technology that has been hitherto largely confined to industrialization or economic development should be amplified in its scope and diffused to cultural, social and other aspects of national development.

Facing the twenty-first century, the Korean Government has set an ambitious goal of joining the group of the ten most advanced countries of the world. For the realization of this goal, the Ministry of Science and Technology prepared in 1986 "A Long-Range Plan for Scientific and Technological Developments Toward the 2000's".

Despite the achievements I have mentioned, Korea still rests far behind the advanced countries in its technological capabilities in terms of R & D funds, manpower, and infrastructure. It would be difficult indeed for Korea to attain international competitiveness in all areas in science and technology with its limited resources. The Korean Government therefore will continue to seek the efficient utilization of available resources by careful selection of priority areas. In the "Long-Term Plan Toward 2000's" different objectives are defined for the R & D fields categorized into the following five groups.

The First Group includes the areas whose economic returns may be expected in the near future, such as informatics, fine chemistry, and precision machinery. For this priority group, the plan sets an ambitious goal to reach the level of the most advanced nations of the world by the year 2000.

The second group encompasses areas with strong possibilities for a medium-term success including biotechnology and new materials. For this group, the goal for the year 2000 is to approach the level of the advanced countries.

Areas related to public welfare, environment and health constitute the third group.

The fourth group consists of such technologies with future prospects as oceanography, aeronautics and space technology. Although the importance of this group is recognized, R & D activities in these fields will be confined to follow-up works to catch up with the advanced countries because of the excessive costs involved.

For the Group No. 3 and No. 4, the goal for the year 2000, is to reach the present level of the advanced countries.

The Fifth Group encompasses basic science and engineering which provide common bases for areas of Group 1 through Group 4. The plan carriers the same goal for this Group as in Group 2.

For effective implementation of the above five groups, the following strategies will be adopted.

The first strategy is to invest the limited resources available in Korea intensively in carefully selected areas.

The second is to encourage cooperative research activities among academia, industry and public research institutions.

Thirdly, the strategy for internationalization of R & D will be pursued in order to overcome the limitations of domestic R & D capabilities.

This is followed by the strategy for localization, the formation of a research and development network across major regions of the country.

And finally, autonomy will be given to the private sectors so that they will be free to benefit from the market mechanism.

By applying these strategies in harmony and balance, we will accelerate the nation's scientific and technological innovation in order to realize our target of joining the ranks of advanced countries by the turn of the century.

Thank you for your attention.

THE ROLE OF ACADEMIA IN SCIENCE POLICY

Professor A. K. Sharma
President, Federation of Asian Scientific Academies and Societies

Dr. Rajakumar, Dr. Kim, Prof. Yan Dongsheng, Dr. Ghani, Dr. So, distinguished fellows of the Academy, guests, Ladies and Gentlemen.

The topic today of the International Conference on Science and Technology for Development is about the science policies of the different governments.

These areas do not belong directly to the government and I may not be in a position to speak very precisely about the policies of the government. However, the scientific community in India to which I belong is privileged to influence the science and technology policies of the government. And as such, I thought I may be in a position to say a few words on this occasion.

Now, the thrust in science is embodied in the science resolution of the government which was adopted in 1958. It emphasized the role of science in the foundation of national policy. It provided ample scope for the generation of new ideas and widening of man's mental horizon to ensure reasonable standards of living. In order to fulfill these objectives, the resolution emphasized the need for the promotion of science, generation of the temper of science, on the one hand, and culture of excellence on the other. For the promotion of these two objectives, the temper of science and culture of excellence, there are two organizations in India. One, the Indian National Science Academy, the premier scientific organization representing the elite scientific community of India, is principally devoted to the culture of excellence in India as well as other objectives they have to fulfill. The other organization is the Indian Science Congress Organization which is devoted to the promotion of the temper of science generating a base of science in this country.

Having the privilege of serving these two organizations in various capacities including that of President for quite sometime, I will try to present before you some ideas as to how these organizations are influencing the policies of the government.

The Indian National Science Academy (INSA) is the autonomous, highest scientific organization in the country. I would like to mention that our Academy, like your Academy, the National Academy of Science and Technology (NAST) is a scientific organization which, although it is financed by the government maintains autonomy in all its decisions. It is patterned after Academies of other countries including the Royal Society, the French Academy of Sciences. Unlike the USSR Academy of Sciences or the Chinese Academy of Sciences, where the structure is much larger and the Academies are also in charge of other institutions in the country, we do not have that sort of structure, only just the Academy of Scientists.

This Academy at present have a strength of a little more than 500 fellowships including the foreign fellows who are elected strictly for scientific eminence. It is also the adhering body of the International Council for Scientific Unions (ICSU) representing the government of India. It has 10 sectional committees for the election of fellowships, for the charting out of the different programs, and the member of committees too. These 10 sectional committees are the crucial bodies of this Academy.

The Academy also operates nearly 30 national committees, all adhering to the International Council for Scientific Union (ICSU); International Union for Biological Sciences, International Union for Medical Sciences.

It identifies and promotes excellence in science and technology and focuses on areas of research or groups of researchers. The nurturing of young scientists was initiated in 1970.

As a developing country, we were seriously concerned with the brain drain which is a common feature in some developing countries. But it is a matter of pride for the Academy to announce that 80% – 90% of the young scientists who have been selected from time to time have chosen to stay in India, even after coming back from abroad. They are now making their mark in different fields of science. Some of the young scientists elected during the earlier years have now become fellows of the Academy.

The Academy organizes, creates policies in energy, health and other series of policy documents and advises the government on matters related to science policies . Although occupying an ex-officio-position, the president of the Academy is member of the science advisory committee to the Cabinet.

The Academy has the privilege of selecting the delegations to be sent to different countries abroad. The government has vested the privilege to the Academy to deal with this aspect. Moreover, on different issues of crisis such as drought, the Indian National Science Academy (INSA) organizes group discussions, organizes seminars, and comes out with policy decisions which the government refers to from time to time.

Though dedicated to the cause of culture of excellence, the Academy is also involved in the popularization of science in the country. It operates a number of local chapters as well as a number of programs. It also sponsors projects, unusual in nature , normally granted to selected young scientists. Once the young scientists are selected by the Academy, they are given a research grant as an incentive. Having earned the status of marked young scientists, they are given privileged positions in all the universities, institutes, and centers of learning. I think the same situation holds good in Philippine setting as well.

It is a matter of pleasure and pride for all of us in the Academy, that the documents produced by the Academy and the opinions of the Fellows are also recommended by the other bodies. This ensures the credibility of the document and demands accountability also on the part of the government. Of course, there is a general feeling in the scientific community that the Academy is running its function principally as an elite scientific body and is not so concerned with the base of science in the country. So in order to bridge the gap, the Academy has undertaken a number of programs through its national committees and local chapters to establish linkage with the general scientific community, as well as that of the fellowship.

Now I come to the other organization, the Indian Science Congress. It represents in general, the cross section of the scientific community of India. There are about 10,000 members and 60% of the members are young scientists. That is why I mentioned from the very beginning that such principal chapter is engaged in the promotion of science and technology base in the country. This was patterned after the British Association for the Advancement of Science for Legacy, the American Association for the Advancement of Science, and other bodies with whom we normally carry out a number of collaborative programs. It is a federal scientific organization with a number of professional and scientific organizations which based annual scientific meetings prior to the Science Congress. There are 30 sections in the Indian Science Congress principally dealing with different aspects of science and original findings which are presented by the young workers at the forum of the Science Congress.

From 1965 to 1967, two committees were formed to establish the contact with the general mass of people. These were the Committee on Social Relations and the Committee on Economic Development. The committees provided the linkage between scientists and the community of people.

Until 1976, I would say that the Science Congress was principally an Academy forum, and of course it had been dealing with both basic and applied aspects of science. A new direction emerged in 1976 when a focal theme was chosen by the Science Congress.

The focal theme introduced by the President during his Presidential Address would be deliberated upon by all the sections coming from all the physical sciences, social relations, and economic development. The resulting recommendations at the end would be sent to the government for implementation. The first focal theme was Science and Integrated Rural Development.

The way the Science Congress has been influencing the policy of the government would be very clear. The focal theme would be the basis of the core plan of the government document next year. So that was the way the Science Congress started influencing the policy of the government.

I would like to mention only those focal themes which directly created impact on government policies. The Integrated Rural Development led to the formulation of rural development as the basic theme for the national planning.

The energy strategies in India which was one of the focal themes, became the basis for the creation of the Department of Alternate Sources of Energy and the Ministry of Energy.

Out of the focal theme on basic researches as integral component of a self-reliant base of science and technology came the technology policy document of the government which was released during the session of the Indian Science Congress.

There was another focal theme on impact of development of science and technology on environment. The results of this was energizing the entire Department of Environment, the inclusion of the environment in all policies of the government, and the development in all policies of the government, and the development of non-governmental organizations dealing with the problems of development.

The focal theme on ocean development, led later on to the creation of the Department of Ocean Development.

The other focal themes included high altitude researchers, environment management, resources of human well-being, frontiers of science, and this year we will be having the technology missions.

In order to put in shape the recommendations of the focal theme, a Task Force headed by the Secretary of the Department of Science and Technology was created. The Chairman of the Task Force reports to the General Assembly the action taken on the recommendations of the last Congress.

This is a part of a defense and accountability on the part of the government. Simultaneously it generates discussions among the scientific communities as to how the recommendations can be partly modified or implemented.

Science Congress too deals with the selection of young scientists. It comes up with different programs dealing with the school teachers, environment, and others. It also operates a number of local chapters.

These are about the organizations which are playing some role in framing the science policy of the government.

I would like to mention at this point that inspite of all the efforts, the tremendous problems, one problem, a problem of population explosion in the country, jeopardizes projections for the future. Simultaneously, policies adopted at the international level such as race for armaments, escalation of well costs, have their tremendous impact on a developing country like India. Inspite of these limitations, and emerging situations often created in unprecedented conditions, the scientific community in India is represented in the professional societies and academies and trying to contribute its share in the process of development, to the process of framing the national policies for economic development.

Thank you very much.

SCIENCE, TECHNOLOGY AND NATIONAL DEVELOPMENT

Dongsheng Yan
Vice President
Federation of Asian Scientific Academies and Societies

It is a great pleasure for me to attend your Conference and indeed an honor to give an address to the distinguished attendants present here today.

Since World War II and especially during the last two decades, a changing pattern of world relationship has emerged between developed countries as well as between developing and developed countries. Interaction, cooperation and collaboration become more and more important between countries, especially in the economic field. Science and technology have been playing an ever increasingly important role in national development as well as in international cooperation.

The science policy of a country depends very much on its economic situation. If I may say a few words about Japan, she has been successful during the last few decades in utilizing the research achievements worldwide and turning them over quickly into commercial products. Microelectronic devices, electrical appliances and in more recent years, automobiles are some of the outstanding examples. Lately, the Japanese Government has, however, been paying more attention to fundamental research as well as to projects of long range nature with an aim to maintain her position in world economic homework through to the 21st. century.

Scientists usually share the common notion that science and technology have their own rules of development. But it is becoming increasingly evident that the science policy of a nation cannot escape to reflect its economic situation speaking from a broadsense. From these arguments, it may be stated that some kind of reform or adjustment in science policy can be looked upon as a world trend.

China is a developing country and is also a big country. To uplift her economic development at a faster pace is not only the general wish of the vast population of the country, but is also an important factor for the stability and peace of the world and especially of the Far East. Therefore, the Chinese Government has put forward the policy that the advancement in economic development should be placed as the most important issue of the country. And science and technology are rightly regarded as the most important elements in national economic and social development.

The Chinese Academy of Sciences, as you gentlemen may know, was founded in 1949 and since then has beeen going through period of growth. It has at present more than 120 Institutes with a total of 45,000 scientists and engineers. These Institutes vary very much in size and cover practically all branches of Natural Sciences and Technological Sciences. As a whole, they are regarded as the comprehensive research center of the country. The Chinese Academy of Sciences, therefore, shoulders a great deal of responsibility for national development. In this respect, some adjustment or reform of the policy of the Chinese Academy from time to time is an objective request to conform to its responsibilities.

The formulation and implementation of recent science policy reform in the Chinese Academy can be traced back at least to the year 1984. Our understandings have gradually deepened and a number of measures have been successively put forward through these years of experience. Most scientists and engineers are keen and enthusiastic to participate in many of the activities and projects for the needs of the country. Nevertheless, we should admit that the present reform is still in its early stage and will proceed and develop over years ahead. I would like to enumerate some of the guidelines as the following:

1. A major portion of our scientific and technological efforts will be devoted to those that are closely related with national scoial and economic development. These can be categorized under the following headings:

    * Participate in National Projects as formulated for each 5 year plan periods, 1986-1990, 1991-1995, 1990-2000.
    * Planning and engaging in comprehensive studies in relation with the development in agriculture.
    * Natural resources and environment studies for decision making from a broad perspective of the country.
    * Research and development in high-technology areas.

2. Fundamental research will continuously be emphasized. We will fully recognize the importance of fundamental research nor only for the understanding of the nature, but more so that many theories and results of fundamental research will turn out to generate new applications at a sooner or later date. Society and mankind will be benefitted from it in the long run.

Ladies and gentlemen, science and technology become more and more of an international affair. The Chinese Academy of Sciences has good and extended cooperations with many academic institutions and universities of foreign countries. The possibilities of developing such cooperative relationships are great. I look forward to closer ties between Chinese and other Asian Countries and the world as well!

Thank you.

SCIENCE AND TECHNOLOGY FOR NATIONAL DEVELOPMENT CHINESE PERCEPTION

Professor Dongsheng Yan
Chinese Academy of Sciences

Most scientists, engineers, and statesmen are aware of the ever-increasing impact of science and technology to national economic and social development. In China, the Government has shown Her great attention by adopting the policy that "economic development must rely on the advancement of science and technology geared to the needs of economic construction. This policy which was formulated by our Premier Zhao Ziyang in 1982 has become the guideline in formulating our science and technology policy.

The Chinese Academy of Sciences founded in 1949 has at present some 120 Institutes with a total enrollment of 80,000, among which 45,000 are scientists and engineers. This is the highest academic institution and comprehensive research center for natural sciences and technological sciences in the country. The Academy has conducted research not only in the basic disciplines but also in applied areas to meet the growing needs of national economic construction and social development. With these basic grounds in mind, we have further set forward the policies of the Academy as follows: strengthen applied research, continue our emphasis on basic research and take an active part on a selected basis in development work. By strengthening applied research, we mean to select and take part in key research projects that are vital to our economic development and to study them systematically so as to uncover the underlying principles governing them in an effort to know how as, well as to know why. By continuing our emphasis on basic research, we mean that we should steadily promote basic research, with emphasis on new frontiers of S & T and those that may have high potential to generate far-reaching influence to the long term development of China's national economy and to elevate our academic level and to contribute to the prosperity of science and welfare of mankind as a whole.

Guided by the principle that science and technology should play a vital role in national development, we have set out to investigate our long-range science and technology strategies at different levels since 1984. Under the state council, a six-men group was entrusted to make a "soft-science" study on this important problem. After six months of intensive work, they have made some important recommendations regarding essentially the general philosophies that a country like China should follow. Some of the main ideas can be enumerated as follows:

1. China is a developing country and is also a big country. She has some very good experts and also some rather high level research and development achievements. But as a whole, our level of development is still low. We should not only cherish and enrich these high points, but also make great efforts to use science and technology as the mainstay to uplift agriculture, industry and the overall economic development of the country, so that by the year 2000, the general economic picture of the country will realize a significant improvement. In this respect, policy is no less important.

2. China should consider independently such labels as "sunrise" and "sunset" enterprise or industries by some people in the developed countries. China should, however, adopt as much as possible "new-technologies" or "advanced-technologies" to renovate her "traditional" industries and to reform her agriculture practice so as to have them placed at much more advanced levels by the year 2000. It is with this perception that the traditional industries and new technologies can and should be interrelated.

3. China should be open-minded to carefully **scrutinize** what are the important advances in science and technology, especially in new technologies both abroad and within the country, that we should not overlook. She should place appropriate emphasis on those areas that she can not afford to neglect. The reward will be significant from a long term perspective. She should then pursue on a limited and identified goal that which can be copied within Her economic means. With persistence and carefully conducted policy, the outcome over a long period will be encouraging.

4. The support that science and technology will depend on the overall economic strength (GNP) of a country. It is also important to publicize to the general public what good science and technology can do if these are properly conducted. It will be unrealistic to ask for more and it will also be unwise if they are undersupported.

At the State Planning Commission and the State Science and Technology Commission level, they also organized a number of task forces to study intensively the role of science and technology by the year 2000, and also the planning of S & T for the five year period, 1986-1990, in coordination with the overall planning of economic and social development of the country. The outcome of these studies includes the identification of important fields of R & D and the formulation of a list of 76 high priority porjects for the 1986-1990 period in science and technology as an integrated part of the general 7th 5-year plan of the country. These 76 projects can be grouped under the following headings for which specific scientific research and development problems will be addressed.

1. Agriculture, Forestry, Cattle and Dairy Farms, Poultry and Marine Resources.
2. Meteorology and Weather Forecast, especially Medium Range, and Disastrous Weather Forecast.
3. Energy Problems: Coal, Oil, Gas, Nuclear, Hydroelectric Power, Dam Constructions and Rural Renewable Energy Resources.

4. Geology and Mining.
5. Materials Research and Development
6. Fertilizers, Insecticide, and Chemical Industries
7. Water Resources
8. Environment and Ecology
9. Medical and Health Care, Local and Foreign Diseases
10. Informatics, Communications and Automation Technology CAD/CAM
11. Fermentation, Enzyme Engineering, Cell Fusion, Chromosome and Genetic Engineering
12. Laser, Microwave, and Infrared Technology and Remote Sensing.

These cover a rather broad spectrum of studies. But for a big country and a vast population like China and for a period of 5 years, we believe these are important and relevant.

Then for the long range, strategic consideration towards the year 2000, their critical investigation identified the following seven fields of high priority:

1. Biotechnology and Genetic Engineering Related Especially to Plants and Animal Breeding
2. New Energy Technologies, Especially Those Related to Nuclear Energy and More Efficient and Cleaner Usage of Fossil Fuels.
3. Computer and Informatic Technologies – Electronic, Electronic – Photonic Hybrid, and Photonic Processing
4. Space Science and Technology
5. Robotics and Automation
6. New Materials and New Devices
7. Emerging Technologies

From the responsibilities and standpoints of the Chinese Academy of Sciences we have also set out to analyze the long range science development program to the year 2000 and that for the Five-year period 1986-90. In order to get a solid background on how things really stand in various branches of sciences, we brought togetehr some 500 senior sceintists for consultation and advice on matters of importance. In addition, similar efforts were also made to organize some 400 scientists to conduct case studies focusing on specific projects. These fact-finding efforts took nearly one year and proved to be very rewarding. On the basis of these recommendations and analyses, we have pinpointed the following eight areas as the nation most pressing concerns up to the end of the century. They include:

Energy
Information Science and Technology
Materials Science and Technology
Transportation
Agricultural Science and Technology
Natural Resources-Exploitation and Rational Usage

Environment and Ecology
Medical Science and Health Care

With the exeption of transportation, the Academy enjoys a fairly solid research foundation and potential in all of the other seven areas, in which she can contribute and has every reason to play a significant role. These analysis have led us to the formation of seven groups in the areas mentioned above which have identified priority fields and projects for research and development.

Ladies and gentlemen, the Chinese perceptions on this major issue are that:

* Science and Technology will play an ever increasingly important role for National Development by the year 2000;

* China will formulate the guiding principles according to Her own needs and at the same time try to be alert and keep abreast with the new developments in important science and technology areas;

* With reform and an-open door policy, we will pinpoint high priority areas from time to time, and push forward the programs in an organized way;

* Close collaboration and association between Academy – Universities – Industrial Sector are highly promoted and encouraged;

* International cooperation in science and technology is a must and will naturally be further promoted.

SCIENCE PERSPECTIVE TO THE YEAR 2000 AND BEYOND: THE PHILIPPINE SITUATION

by

Academician Paulo C. Campos, M.D.
President
National Academy of Science and Technology

I. Introduction

Today, as never before, the Philippines has felt the need to enunciate a clear-cut and more effective policy in science and technology which is an indispensable tool for national self-reliance and self-sufficiency. The reasons for this felt need are manifold. First, there is a rising demand for advancement in science and technology as countries and regions are drawn into much closer interaction as differences in the standard of living among nations are increasingly obvious. Second, science and technology are much more intimately related to each other than in the past. Thus, as a developing country, the Philippines must attempt not only to approach, by adaptation, a much higher level of science and technology, but it must also reach for science and technology that are invariably and rapidly moving to higher levels. Third, the situation in the country undergoes continual changes. The Philippines is a country with a still dominant majority of her manpower in agriculture. At the same time, it has set up structures in science and technology which, on the other hand, should facilitate its economic development strategy and, on the other, should serve as one of the instruments in improving the quality of life.

For some time, because of the slow pace and unsettled direction of its science and technology system, the Philippines has been deservingly criticized for poor performance. Several sectors have pointed out the existence of the disparity between the level of the Philippines' science and technology and those of the advanced countries in Asia. It may be worthwhile mentioning here that there are some things in the Philippines which come close to or which surpass advanced Asian countries. However, they represent only a part of the whole, and a relatively small part at that, and in most cases the Philippines is relatively backward.

Thus, the question is whether the Philippines should gradually narrow the disparity and catch up with the levels of advanced Asian countries. In order to deal with the situation, the science community through the National Academy of Science and Technology (NAST) has decided to take up the challenge. A series of science fora were held to clarify the latest trends and issues vis-a-vis directions of the development of science and technology in the country. Penetrating discussions and consultations on science and technology policy for the next decade were carried out and the various sectors of the Philippine society were involved.

The following are some shared perceptions of the various sectors of the nature of S & T issues and their interrelations with other problems and the efforts to deal with them:

* The imbalance of present Philippine economic conditions make it extremely difficult to bring about sustained improvement in the S & T situation. Accelerated and balanced national development and lasting improvements in the country's S & T require improved economic conditions.

* S & T issues are closely intertwined with development policies and practices. Consequently, S & T goals and actions need to be defined in relation to development objectives and policies.

* S & T provide constrainsts as well as opportunities for economic growth and social well-being. S & T constraints, however, are gnerally relative to the socio-economic conditons which can and should be improved to achieve sustained national economic growth.

* Building awareness at various levels of the importance of S & T through the provision of information, education and training is essential for S & T development.

* Strategies to deal with S & T challenges have to be flexible and should allow for adjustments to emerging problems and evolving S & T management techniques.

Science and technology problems cut across a range of policy issues and are mostly rooted in inappropriate development patterns. Consequently, S & T issues, goals and actions cannot be framed in isolation from the development and policy sectors in which they emanate. Against this background, and in the light of the outcome of roundtable conferences on science policy sponsored by the National Academy of Science and Technology, this report/paper reflects an intersectoral consensus on growing S&T challenges to the year 2000 and beyond, in respect of five main sectors. Throughout the perspective an attempt has been made to reflect consistently the interdependent and integrated nature of S & T issues. Under each sectoral heading the report covers: the issues and outlook; the goal to be aspired to in dealing with the issues; and recommended action. While drawing upon the presentations of scientists, researchers, engineers and technologists, the perspective has sought to delineate in an organized manner, the elements of shared perceptions, S & T issues, aspirational goals and agenda for action envisaged for the perspective by the National Academy of Science and Technology.

II. Sectoral Issues

A. Policymaking, Legislation and Funding

A.1 Issue and Outlook

Issue: The optimum contribution of science and technology to achieve sustainable national development has not been achieved due to lags. The scientific and technological backwardness and dependence in the Philippines may be attributed to deficient policymaking, weak legislation and inadequate financing which have tended to create serious disequilibria between science and technology and economic development.

Outlook: In the Philippines, the development of S & T has been influenced by colonial mentality and dependence. The country has remained heavily dependent on S & T which have been developed in other countries for its industrial production and distribution as well as its consumer goods. This is partly a reflection of its dependent economy which has remained largely agricultural. There is not much challenge, demand or support for Philippine S & T development as local industries simply import their machineries, processes and even raw materials.

In order to achieve prompt economy recovery and countryside development in terms of increasing productivity in agriculture, industry and energy, S & T which form an integral part of the government's Development Plan should be backstopped by appropriate policies, strong legislation and sufficient funding.

The government has always had plans, strategies and programs, but most often these have not been translated into actual and successful operations. One major impediment has been always the absence of ample financing.

A case in point relates to the General Appropriations Act which reflects the national priority scheme for S & T, both in terms of national revenue allotted to it and the support given to its various components. Direct appropriations to S & T (i.e., the budget of Department of Science and Technology) is only 0.07 percent of Gross National Product. In contrast, other developing countries, including advanced nations, earmark as much as three to five percent of their GNP for S & T development.

Experience has shown that S & T in the Philippines have had to compete with various priorities of government in getting the much-needed budgetary support. Defending research activities, the outputs of which are not tangible, is not easy. Results of development research remain one of the most difficult areas to measure in terms of accomplishments, cost-benefit ratio and impact. In this process, S & T more often than not lose out to more tangible projects like infrastructures.

A.2 Goal and Recommended Action

Goal: Achievement over time of such a balance between essential inputs for S & T and the expected outputs as would make possible sustainable development, keeping in view the links among policymaking, legislation and funding.

Recommended Action:

(a) S & T should be always assured of adequate funding regardless of the changes in political leadership. As such, the national government should earmark not less than one percent of GNP for R & D and 1.5 percent for S & T up to 1992.

(b) The revival of a Special Science Fund should be considered favorably. This is to be composed of one or two productive revenue-sources in the form of earmarked taxes either on casino earnings or on sales of beer and cigarettes. This would mean not only suitable facilities and better working conditions but competitive salary rates to minimize the exodus of high-caliber scientists and top-notch researchers and technologists from the government agency to the private sector or from inside the country to outside.

(c) Incentive provisions should be given ample attention but these should be formulated carefully so that a structure of S & T incentives which will be cost effective and efficient can be evolved. Incentives, if loosely given, would only serve as tax shelters and result to revenue loss, distorted allocation of resources and worsened inequity problems.

(d) Scientists, researchers and engineers should be interested and participate actively in vital areas of policymaking such as laws on import liberalization and those granting incentives to transnational corporations should be studied carefully for their possible impact on existing R & D programs and the development of indigenous industries. The policy of *import liberalization* may lead to the stifling of local inventions and technological innovations.

(e) Government agencies like National Economic and Development Authority, Department of Trade and Industry, and Department of Transportation and Communications should continually consult local scientists, researchers and engineers on science and technology-related policy matters. Filipino scientists, researchers and engineers, on the other hand, should be ready to provide advice to policymakers on S&T matters.

B. Education and Culture

B. Issue and Outlook

Issue: There are vast disparities in the patterns of Philippine educational system in the context of science and technology. On the one hand, it is necessary to ensure that the benefits of education reach down to the broad masses of people. On the other hand, it is equally important for a country aiming at industrialization to have a wide range of highly qualified professional cadres that are specialists particularly along the fields of science and technology. These two different needs equally urgent, have not been reconciled. Although science and technology are crucial to the development process, there has been little concerted action for balancing educational imperatives and S & T demands.

Outlook: It is well accepted that science is part of culture. Sadly, science is not yet part of the culture of Filipinos. In the modernization efforts, one of the decisive factors is not only training more agricultural scientists and technicians but raising the farmers' level of sophistication and knowledge in science and technology.

The educational approach for the masses of population is nonformal which is intended for large numbers of children who are out of school and adults who have no access to further training, education and other means of self-improvement. What these big groups need is mainly a practical-type science education that can help to improve the quality of life.

Alongside the effort to educate many of the masses, the education of the select few who will go on to scientific careers should not be neglected. This elitist group will contribute to leadership on education and productivity needed to maximize the resources for development. With higher level of scientific knowledge, society shall be able to absorb, modify and improve an imported technology and build an indigenous one for the development of the country.

Thus, there is a need for scientists who will discover and develop the basic concepts of research and experimentation using the country's indigenous resources; and trained men and women such as technologists and skilled workers who will convert the country's abundant raw materials into competitive products in the world market.

The inadequacies of scientific and technological manpower may be perceived as critical today especially in view of socio-economic needs of the Philippine society. The needs and opportuniies for utilizing such trained manpower call for the involvement of not only the scientists, researchers, engineers and technologists who serve in the government sector but more from those who come from industry and the private sector.

At this point in time, why has the Philippines lagged behind in terms of producing an "elitist group" in science and technology? One major reason would be traceable to a fundamental shortcoming of the educational system. The failure to instill in the Filipino a truly scientific mind stems from the neglect of science in the elementary and secondary levels. With irrelevant curricular emphasis and science teacher incompetence, educators have failed to consider that molding the mind of the young has a tremendous impact on the future adult's thinking. Furthermore, educators in the secondary level, capitalizing on the elementary level exposure of the youth to the world science, have neglected to inculcate logical thinking, inquisitiveness and precision which are the hallmarks of the scientific mind.

At the tertiary level, science and technology have not been given a boost by more vigorous funding support from both government and private sectors. Education for science and technology is relatively more expensive than for other courses. Thus, many of the private universities and colleges either hesitate to provide for these areas of education or do so at great sacrifice to the standard of excellence in science. Besides, only a few students are attracted to go into science and technology courses because of the dearth of job opportunities available in the country for R & D scientists and technologists. Those who are inclined to science careers are often eventually lost to the country as part of the international brain drain.

B.2 Goal and Recommended Action

Goal: Sustained commitment to an equitable and qualitative system of education aimed at developing a strong capability in science and technology.

Recommended Action:

(a) The science community should be strongly and continually represented in the planning sessions of the Department of Education, Culture and Sports with regard to science and technology. The priorities of science education relevant to the needs for scientific and technological manpower should be articulated. A systematic connection between science and education in the Philippines should be accorded due recognition.

(b) The government and the private sector should earmark substantial investments of funds for the growth of science and technology in order to educate and train a large pool of R & D scientists and researchers; and provide for a national network of R & D facilities and adequate financing of R & D activities. These items of expenditure would be directed at strengthening the country's universities and colleges.

(c) Giant corporations should allocate a portion of their profits, say three or four percent, to scientific research as commonly practiced in advanced countries.

(d) Concerted efforts must be directed toward the raising of the academic standard in the context of science education in the elementary level by strengthening the course (science) content and by upgrading the competence of science teachers.

(e) Corollary to item (d) is the move to break open the policy of confining science teaching jobs to the graduates of education. There should be a shift in the recruitment of science teachers, i.e., from the method-oriented to the subject-matter-oriented, which would include people with A.B. and B.S. degrees.

(f) Teacher training colleges should be attached to a good College of Science in order to produce science teachers which will have both the expertise and the methodology.

(g) Science and mathematics centers should be set up in the elementary and secondary levels to make the youth more science-oriented.

(h) In order to produce the "elitist group" in science and technology, the national government should adopt the following educational scheme:

(1) There should be at least one good science high school in every province where potential scientists are concentrated. Residential facilities would be needed to accommodate the students that will have to be drawn from all parts of the province.

(2) The best graduates from these science high schools, particularly those with exceptional performance in science subjects should be granted scholarships for the undergraduate program (first degree) particularly along the pure sciences, physics, biology, chemistry and mathematics. These scholars should be concentrated in four or five places in the country.

(3) Outstanding graduates of baccalaureate degrees in the sciences should be encouraged to pursue graduate studies which are expectedly more specialized.

Graduate fellowships, scholarships should be made available to hundreds of grantees who later will staff colleges and high schools, thus strengthening curricular offerings in science and technology.

(4) From among these M.S. degree holders would be an influx of scholarship grantees for the Ph.D. program who should study only in the Manila science consortium institutions, particularly the University of the Philippines to obtain their doctorates. These would create a body of scientists and professionals for the academe and for research institutions.

C. Basic Sciences and Advanced Technology Research

C.1 Issue and Outlook

Issue: The Philippines has been left behind economically and technologically by its neighboring countries due to the vicious cycle of S & T backwardness and economic dependence. As a result, the basic sciences and advanced technology research have been relegated to an utterly low position in the government's development priorities and in the Philippine society's cultural values. Opposed as impractical and discouraged as irrelevant, basic sciences and advanced technology research in the country could do more than languish at mere subsistence level.

Outlook: The vicious cycle of S & T backwardness and economic dependence stems from: (a) weakness of the country's scientific and technological potential (STP); (b) lack of effective demand for indigenous R & D and technological innovations; and (c) almost total dependence on imported technology. To break the vicious cycle, the following essential components of national strategy must be given serious consideration: (a) accelerated massive development of the country's STP; (b) increase in effective demand for indigenous R & D and technological innovations through fiscal policies and legislative acts which will make local firms invest a certain percent of net income before taxes on R & D; and (c) strategic management of technology transfer which will link imported technology with indigenous R & D to facilitate national mastery of selected technology.

Third Wave or Emerging Technologies offer opportunities for economic development because of their knowledge-intensive and capital-savings characteristics. The country should try to find niches among the Third Wave Technologies that it can master and turn into economic advantage.

Thus, the government should attempt to adopt the "leapfrogging strategy" an essential factor of which is the linkage of selected transfer of Third Wave Technology with indigenous R & D and technological innovation. The purpose of this strategy is to build up adaptive, replicative, innovative and ultimately, creative capabilities in these technologies.

There is a close linkage between the Third Wave Technologies and the basic sciences (biology, chemistry, physics, mathematics and earth sciences). As such, it is essential that the latter be developed by a massive and sustained manpower program. Hand in hand with it is an infrastructure development program related to selected areas of high technology (computer and information technologies, material science, microelectronics, photonics, biotechnology, automation and instrumentation). Selected R & D projects in these areas have to be initiated.

The status of the basic sciences and advanced technology research in the country as seen in a global and even in a regional context has deteriorated. While all the leading and emerging industrialized countries have grand plans for their S & T, the Philippines has barely started making one. To continue to ignore the basic sciences and advanced technology research will surely relegate the country to the status of a S & T colony.

Consideration of a plan for S & T is critical to the country's economic survival. The very strategy for industrialization in the Philippines depends largely on its S & T. Careful planning and deliberate management of the basic sciences and the advanced technologies by the government sector and technology-based industries should become common features of the forthcoming years. Constraints of limited financial, human and natural resources, especially keen competition, have sharpened the need for S & T management.

In the country's search for directions in S & T, there should be a conscious and deliberate effort to develop fundamental capabilities along chemistry and biotechnology. The impact of these "science-oriented" researches in agriculture, health and industry has been increasingly evidenced visibly.

For instance, chemists in the country are now capable of designing and synthesizing drugs and other materials for a particular purpose, considering that chemistry research is still in its growth phase. Undoubtedly, chemistry will be a fruitful area of research and investment for many years, recognizing its indispensable usefulness in the food and the polymer industries, ***inter alia.***

On the other hand, biotechnology must be harnessed to modernize production and diversify product outputs. Research and development activities in plant biotechnology have been focused on the understanding of the molecular basis of many plant processes and applying this knowledge towards crop improvement. Similarly, advances in research along animal biotechnology are geared towards new techniques in animal breeding, animal health and animal nutrition.

On the whole, the potential role that biotechnology and molecular biology together with the other basic sciences can play in national development is so great that the government must thrive to harness these new knowledge to transform Philippine society into one that is productively at par with its neighbors.

C.2 Goal and Recommended Action

Goal: Full development of the basic sciences in the Philippines as a necessary (though not a sufficient) condition for achieving advanced technological self-reliance, modern industrialization and genuine economic independence. By developing a strong capability in the basic sciences, the country can gain access to the dynamic aspects of the new sophisticated technologies and establish its own science-reliance, modern industrialization and genuine economic independence. By developing a strong capability in the basic sciences, the country can gain access to the

dynamic aspects of the new sophisticated technologies and establish its own science-based industries.

Recommended Action:

(a) The government should articulate long-term comprehensive plan for industrialization which includes well-defined, feasible targets and realistic time-tables.

(b) The requird manpower and institutions to provide the S & T component for the accomplishment of the industrialization plan in item (a) should be vigorously and continuously developed. Science and technology development is expensive and unless it is within such a long-term plan, such development would be difficult to justify and maintain.

The following are the proposals until 1992:

(1) The government should aim for half of the UN target (380 R & D professionals per million for developing countries), i.e., increase (the current level calculated to be 145 R & D professionals per million) to 190 R & D professionals per million. It means increasing from the present 8,000 local R & D scientists to 12,000 by 1992. This will require a massive program in the next four years.

(2) The Philippines is weak in technicians. Thus, the government should go into a massive training of technicians to achieve a ratio of two R & D technician to every one R & D professionals.

(3) Institutions involved in R & D along selected areas of science and advanced technology should be strengthened by setting up several specialized research institutes.

(4) There should be provision for scholarships and fellowships for M.S. and Ph.D. studies both here and abroad in natural science and mathematics and in engineering sciences.

(c) To alleviate the inadequacy of S & T manpower resource, the government should tap expatriate scientists or suitable expets to thelp us develop in specific areas. The government should address the perennial lack of proper professional and financial incentives to the scientists.

(d) The international cooperation program should be continued and stength-ened.

(e) A cooperative and sustained effort should be devoted to build up, in addition to the human resource, necessary instrumentation and other support facilities such as libraries (with updated scientific literature and information) with which to carry out R & D in the basic sciences (particularly chemistry and bio-technology) and advanced technologies.

(f) The government should have an explicit commitment to S & T which must be reflected in its inclusion of S & T plan in the national long-term (15-20 years) and short-term (three to five years) development agenda.

(g) The S & T plan should be sustained beyond any particular political administration evidenced by its adequate funding.

(h) The national science policy should be discussed actively at the highest levels of planning.

(i) The government should shed its cumbersome bureaucratic structure especially in the implementation stage of the S & T plan. The bureaucracy should be staffed with scientifically-literate and innovative personnel in all its departments.

D. Health Science

D.1 Issue and Outlook

Issue: Research performance in the field of medicine particularly health science has not been at par with that of Asian neighbors much less with that of developed countries.

Outlook: The status of health research in the Philippines does not depict a desirable picture in terms of quantity and quality. This seemingly dismal situation may be attributed to the meager resources being allocated by the government to this aspect of health services considering that the economic benefits derived from health research are largely indirect and not rigidly quantified. Besides, research manpower along the basic sciences in medical schools consists mainly of medical doctors who make good physicians but not researchers or scientists. They have no adequate training for in-depth researches. The few staff who have Ph.D. degrees are either in administrative posts or have migrated out of the country.

The backbone of a health research system depends on the institutions implementing the national health research program. With proper equipment and capable research personnel, the contribution of such institutions to the attainment of health research objectives cannot be overemphasized. As such, the developing and/or strengthening of institutions capable of undertaking research becomes one of the major thrusts of the government in order to catch up with other developing countries along health research.

Goal: Enhancement of health research capabilities to meet present and future scientific requirements of health development and institution building.

Recommended Action:

(a) A health network which includes coordination between and/or among health research agencies and academic institutions should be developed to hasten the pace of health research and optimize the utilization and distribution of resources.

(b) The development of physical resources should follow a consortium approach, i.e., institutions proximate to one another need to necessarily possess the same type of laboratory equipment or library holdings. Thus, an institution may be in a position to share its resources with other institutions.

(c) The formulation of science communities should be aggressively encouraged to promote sharing of facilities and resources such as libraries, computer services and laboratories between and among members.

(d) A "critical mass' of health research manpower in the different regions of the country, should be vigorously developed in order to contribute to the existing pool of research expertise.

(e) To carry out item (d), scholarships/fellowships and thesis/dissertation assistance for degree programs should be made available. For nondegree programs, travel grants and observation tours, training programs, research fellowships and study exchange programs should be offered.

(f) Existing institutions engaged in health research activities should be strengthened to maximize their potential to be centers of excellence for teaching, training and research.

(g) The Department of Health should, have maximum involvement in the planning of strategies for the implementation of the health research program considering its leadership role in health and related matters in the country.

(h) The government should encourage the active participation of the private sector in planning, financing and implementing health research.

(i) The government should establish an information system to meet the requirements of policymakers, research managers, researchers and research result users.

(j) The national government should generate funds to support health R & D activities.

E. Environment Conservation and Management

E.1 Issue and Outlook

Issue: An emerging crisis which needs to be addressed is the deterioration of the country's environment; the depletion of its natural resources; and the destruction of its life-support systems which includes extinction of flora and fauna species and pollution of air, soil and water. This is a neglected concern because it is seen as being "economically nonproductive" and an outright hindrance to "progress". Nonetheless, it is a significant challenge to the Philippine society and its scientific capabilities.

Outlook: There has been a growing awareness of environmental issues among and within the various sectors of the Philippine society. The expansion of the Department of Natural Resources into DENR with the appended "Environment' component, especially the inclusion of the Environmental Management Bureau (EMB) is but one sign of this growth of common concern.

Environmental impact of actions in one sector is often felt in other sectors. As such environmental considerations should be taken in the context of sectoral policies and programs and their coordination is essential to achieve sustainable development. The interdependent and integrated nature of environmental issues should be noted.

It is unfortunate that science and technology have not had a considerable impact on industry. There has been comparatively little interaction between the

the industrial/business community and the S & T sector. These two aspects or components of national development are undeniably related. Thus, unless a strong linkage is established, these two will simply drift apart without developing any mutual appreciation and support for each other.

Industrial development brings obvious benefits, but it frequently entails damage to the environment and to human health. Industrialization patterns and the consequent exploitation of natural resources and environmental degradation have been markedly unbalanced.

Although some efforts to deal with environmental problems of industry have been made, negative impacts will grow in magnitude if not addressed methodically and scientifically. A promising trend is the steadily growing awareness of industrial environment risks throughout the country. While this awareness increasingly informs and influences the public, environmental knowledge remains as yet markedly uneven. Inadequate knowledge at the grassroots level of changes in the environment and of their causes as well as economic implications impedes participation of the people concerned.

Insufficient attention to the environmental impact of agricultural policies and practices, combined with the quest to meet rapidly growing food needs, has been causing great environmental damage. In the absence of proper environmental management, conversion of forests and grassland into cropland will increase land degradation. The pressure on the natural resources, including those in the public domain, is a serious concern.

The use of high-yielding seed varieties has multiplied agricultural output but had led to a reduction in genetic diversity of crops and an increase in their vulnerability to diseases and pests. The emerging technology of direct gene transfer can greatly increase production and reduce costs.

Overuse of pesticides has polluted water and soil, damaging the ecology of agiculture and has created hazards for human health and animals. Pesticides have to be used to increase agricultural production. But their indiscriminate use has destroyed natural predators and other nontarget species, and increased resistance in target species.

E.2 Goal and Recommended Action

Goal: An integrated R & D program with emphasis on the S & T component on environmental conservation and management to improve the country's environmental conditions.

Recommended Action:

(a) Existing environmental policies should be reviewed/studied thoroughly by a multidisciplinary group headed by the Director of the Environmental Management Bureau in order to effect amendments/revisions on the formulation of policy statements in the light of recent developments in environmental management.

(b) Studies relevant to environmental issues/problems should be conducted to serve as basis for eventual formulation of laws and regulations in environmental management.

(c) A periodic environmental impact assessment should be undertaken on a regional basis to determine the environmental status of the country.

(d) A sustained R & D program with emphasis on priority areas of concern along environmental conservation and management should be adequately funded by the national government with the assistance of the private sector.

(e) The Industry Sector should consider seriously such recommended actions as follows:

(1) The government should provide for environmental standards and their enforcement; specifically, it should ensure penalties for non-compliance, in comformity with the "Polluter Pays Principle".

(2) Industrial enterprises should carry out environmental impact and social cost-benefit analyses prior to the siting and design of industrial plants. The government should ensure that such analyses are carried out and made public.

(3) The government and industrial enterprises should be receptive to the views of citizen groups, community associations, labor organizations and professional/scientific bodies in arriving at, and implementing, the decisions on industrial siting, design and technologies to meet the environmental, economic and social needs of the people.

(f) The Agricultural Sector should carry out the following recommended actions:

(1) The government should design and implement regulatory measures as as well as taxation and price policies and incentives aimed at ensuring that the right of owning agricultural land carries an obligation to sustain its productivity.

(2) Public education, information campaigns, technical assistance, training, legislation, standards setting and incentives should be oriented to encourage the use of organic matter in agriculture. The use of fertilizers and pesticides has to be guided, *inter alia* through training, awareness building and appropriate price policies so as to establish integrated nutrient supply systems responsive to environmental impacts. Similarly, subsidies, which have led to the overuse or abuse of chemical fertilizers and pesticides, have to be phased out.

(3) Local communities should be involved in the design and implementation of agricultural policies which should vary from region to region to reflect different regional needs, encouraging farmers to adopt practices that are ecologically sustainable in their own areas and promote national food security.

III. Concluding Remarks

The role science plays in bridging the gap between man and development is more than just a catalyst. Its commitment to development resembles the participation of an essential coenzyme in a biochemical reaction. Without science, the linkage between two substrates: man and development through the ligase enzyme: technology, may not occur or may occur at a dramtically slow rate.

Definite science policy statements have to be made and these have to be made now. There are but two choices: either to move ahead or fall back. There is no standstill in a world of dynamic changes.

SCIENCE AND TECHNOLOGY: VITAL KEY TO ACCELERATED DEVELOPMENT

Senator Jose D. Lina, Jr.
Chairman, Senate Committee on Science and Technology

MR. PRESIDENT:

I rise to speak today on a matter of collective privilege and on a question of national interest affecting the present and the future of this country.

This Representation wishes to call the attention of this august body and the Filipino people to the state of science and technology as the Chairman of the Senate Committee on Science and Technology.

As of this day, we have approved the landmark legislation on agrarian reform. We also endorsed recently the free secondary education measure. Pending for third reading is the important issue of debt service and the creation of a joint legislative-executive commission thereon. We are presently discussing an industrial peace and incentives bill. All these pieces of legislation Mr. President, have a common denominator or aspect: the need to infuse science and technology to make these measures workable for the welfare of the people.

We need not only to distribute land to the landless, but also to augment the income and improve the livelihood of the beneficiaries of land reform with the adoption of appropriate technology in agricultural activities. Science education as part of the quality education package is important if the 3.58 million expected to enrol in secondary schools, public and private, are to be prepared for livelihood skills and productivity and to develop a concern and awareness of science as a tool for living. If this country is going to generate additional revenue sources to service our whopping $26B foreign debt, we shall need to harness technology in industry and export products. The incentives bill presently being discussed uses increased productivity by the labor sector as a basis for tax deduction. Again, any increase in productivity presupposes substantial technology inputs.

Today we are concerned about poverty reduction alleviation as an indispensable component for the attainment of a better quality of life for our people. We need economic recovery and accelerated development that will match, if not surpass, the economic miracles that our Asian neighbors appear to be enjoying today. To support our struggle for political stability and economic self-reliance, we need a level of productivity and progress that will not only generate a livelihood for our millions of literate manpower resources, maximize utilization of our bountiful natural resources without sacrificing their integrity and ecological balance, but provide direction towards a way of life that upholds justice and gives everyone an opportunity to enjoy a decent standard of living over and beyond the basic necessities.

We believe, Mr. President, that science and technology is the vital key to ignite and put into motion our people's efforts and determination to develop into a self-reliant, free nation. We must take that quantum leap of faith and hope into the future. We must make those giant economic strides when we enter into the year 2000. We need to overtake and match, stride for stride, strength for strength, step by step the newly-industrialized countries of the Third World and leave our present static status of a slow developing nation. We can do this, Mr. President, if we face the reality that our country must restructure the national plan for science and technology and infuse in every sector – agriculture, industry, education, health, labor-research and development activities geared to productivity and fullest utilization of appropriate knowledge and technology and maximum investment in science and development, both in financial resources and manpower.

National Philosophy and Commitment

A degree of control and command over nature and its resources is an ever-present reality in any nation's progress. The greater the degree of that control, the deeper the understanding of the forces of the earth – the more superior the economic development of a people and a nation. For the colonizers of the past and the developed countries of today, their development edge is in the way they have utilized knowledge and harnessed science to increase their gross national product. In fact, the developed countries like Japan and Taiwan and the developed cities of Singapore and Hongkong have limited natural resources, but have forged ahead nonetheless. Our resources match that of the newly-industrialized countries like South Korea and the emerging Asian countries with impressive growth rates, such as Malaysia, Thailand, Indonesia and Pakistan. But while during the fifties and sixties we kept abreast, if not ahead, of some of the developing countries of Asia, today, in the eighties we have lagged behind; with many of our industries obsolete and our research and adaptation of new technologies far behind that of our neighbors.

Our commitment to science and technology is inscribed in the Constitution. This is a good new beginning. But we need a more stirring mission statement for accelerated development through commitment of national awareness, funds and the concerted action of all our policy-makers and implementors to focus major attention on research and development and to direct our resources towards retooling for agriculture and industry and aggressive adaptation, innovation, invention of available science and appropriate technology.

What is the current scenario for research and development expenditures? In the early eighties, the Philippines lagged far behind in research and development expenditures as a percentage of gross national product. The United Nations recommend a level of a least one percent of gross national product for such expenditures. By 1982, this country devoted a mere 0.2 percent of GNP to research and development expenditures. Compare this percentage of GNP to Singapore and Thailand which was 0.3 percent; Indonesia, 0.4 percent; Malaysia, 0.6 percent; India, 0.7 percent; Korea, 1.1 percent; and Japan, 2.6 percent.

Our national development plan projects 0.32 percent as of 1988; only by 1992 will research and development expenditures be expected to be 0.9 percent; but still 0.1 percent below the United Nations recommended level of one percent. This means, however, that in four years or early 1990's, our plans for research and development expenditures will not even reach what Korea was spending of 1.1 percent of GNP in 1982, or ten years before 1992! How can we catch up in four years, when our level of spending for research and development will only match that of Korea ten years before that time!

Clearly, we need to review and revise upwards our plan for research and development spending as a percentage of gross national product. We need also to remember that the gross national product of Asian developed nations, like Japan, Singapore, Taiwan, South Korea and the city of Hongkong is far greater than our level of GNP and is increasing at a greater rate than ours. Moreover, this same observation can be made of the countries which have had impressive growth in the eighties, namely Malaysia, Indonesia, Thailand and Pakistan – their GNP is larger, so that 1 percent or more of their larger GNP is considerably bigger in expenditures for research and development.

It has been shown that research and development investment and science and technology input are a key factor of economic growth and development. For highly developed countries, like Japan, West Germany and the USA, science and technology accounts for some 50 to 70 percent of economic growth. For newly industrialized countries, like Singapore, South Korea and Taiwan and the city of Hongkong, science and technology results in from 45 to 55 percent of economic growth. For developing Asian countries with impressive growth rates in the eighties, more than 30 percent of economic growth may be attributed to science and technology infusion.

The trouble, of course, is the cycle of the greater the inputs of research, science and technology – the greater the economic growth and the more money becomes available to infuse in science and technology. The less the inputs of research, science and technology, the slower the economic growth and the less money becomes available for technology investment.

The Philippines is within the cycle of less inputs, slow economic growth, and less money available for science and technology investment. Therefore, we need a bolder strategy, Mr. President, let us break the cycle of less input, less growth, less resource investment – by investing more despite our limited resources and thereby breaking the vicious cycle less and less – by starting of cycle more inputs and accelerated growth.

Frontiers of Science and Technology

Mr. President, we have barely touched the bold and ever-widening functions of science and technology.

For the record, the Senate Committee on Science and Technology requests that Annex A-1 entitled, "Significant Advances Expected in the 1990's" and Annex A-2 entitled, "Chart of the Future," be included in the records of the Senate and distributed among the members of the august chamber.

Significant advances expected in the 1990's – some of these are already available as of today – include the science and technology areas of achievement in the eighties or will be available in the nineties. These areas include: biology, physics, materials, energy, environment, earth and marine, laser and optical computer, space cybernetics, theoretical physics, mathematics, medicine, and agriculture. Nearly all of the advances in the sciences and in technology maybe adapted for conditions in a developing country – whether as a consumer of these achievements or a producer of the same. These significant achievements of man may be utilized for industry, agriculture, business, education, health. Indeed the peaceful uses of scientific knowledge and the accompanying technology which enables mankind to improve his life and living have no known limits, other than the state of available knowledge (and this is fast growing and advancing), logic and lessor, and of course logistics or financing.

The other document which is a chart of the future is mind-boggling. The possibilities of what mankind can do in the twenty-first century are tremendous. Let us critically examine both: the advances of the 1990's and the chart of the future and make our national plan for adaptation, innovation and invention. Given the time, resources and the genius of men virtually anything is possible which will improve our knowledge, our style of life and the world we live in.

For the Philippines, what we need now is judicious selection and adapt what is already or will be soon available to ignite our economy. Whatever needs to be done, let the reasonable men among us plan that which is within reason. Let us find the resources for our research and development. We need to send our very best young men and the keenest minds to study these latest advances and devise ways which will use scientific knowledge and advanced technology to improve the life of our farmers, our workers in industries, our students and the academe, and the Filipino family.

We will improve our national plan of action for science and technology and implement the same using incentives for the private sector, scientists and inventors. We will boldly plan for our resources aware that these constitute our patrimony and use of stewardship to harness and protect our wealth through the wise application of knowledge and technological management.

Let us make a national inventory of our products and goods with commercial potential and adapt the technology appropriate to maximize their use and propagation.

Our breakthroughs in prawn and milkfish culture should not allow us to rest, but to actively pursue similar breakthroughs in other marine life and marine resources.

We must break away from being mere suppliers of raw materials and be courageous enough to opt for exporting finished products.

Ours must be a need-based model for action and resources support. The need must be that of our rural farmers and urban workers in industry. The need must be that of micro, cottage, small, and medium scale enterpries. The need must be that of entrepreneurs, whether of small businesses or of large corporate structures.

We need to increase support for research through the public sector and provide incentives and rewards for research funds from the private sector. As of today, support from industry for research is a modest 13.2 percent.

We should provide assistance and encouragement for the retooling and upgrading of our obsolete factories, some of which are behind 20 to 30 yeaars in technology.

While production of import substitutes is desirable, science and technology should make possible new products for domestic and international markets. Look what Thailand has done for her fruits and vegetables. Israel took the Philippine avocado and is now exporting the improved variety to Europe.

A Quantum Leap of Faith and Hope

Science is a double-bladed weapon in the hands of mankind. A laser beam can search out a cancerous growth in a man's brain and yet be used as a fearsome weapon for war. The peaceful uses of nuclear energy and power for healing and research on diseases are just beginning to be felt; but ironically the nuclear and atomic age was ushered by the horrors of Hiroshima and Nagasaki.

Nuclear power is man's option for fueling future industries and enterprises. But the disposal of dangerous wastes and the accidents at Chernobyl and Three-Mile are just the tip of the iceberg of the frightening effect of radiation carried by winds silently and with deadly effect.

Just as man fought the dinosaurs of the past, he must conquer the dangers or at least control the effects of scientific advances, such as nuclear energy.

Legislators and policy-makers of today must therefore weigh the advantages and benefits of scientific progress vis-a-vis the actual or potential danger to mankind. We need to face the risks, but we must take some risk to be able to make the huge leap into the future that science and technology can make possible for this country.

The legislative agenda must first take into account the Constitutional mandate on science and technology. Then we need to take an inventory of our natural resources and of the possibilities of available technology. There must be a balance, admittedly at times precarious, between use and abuse of the environment. There have to be decisions to be made on allocation of resources. We must seriously consider greater resource infusion into science and technology, more incentives for research and development for these activities themselves account for economic growth and development. Expenditures for research and development are investments for greater growth and productivity.

Mr. President, we must make the decision today that will enable this country to move into the next century, which is but 12 years away. We must act now or be left behind. Already we lag behind in economic development. We must not falter now, tomorrow might be too late. The eighteen year olds by year 2000 will now be entering preschool. All children born from today are the adults of the next century. We must make that quantum leap for development.

We must do so with faith, with hope and with conviction.

A-1 to Privilege Speech of Senator Lina, Jr. on Science and Technology: Key to Progress and Accelerated Development
Source: Paper of Ceferino L. Follosco entitled, "Gaps in Technology," December 1984.

SIGNIFICANT ADVANCES EXPECTED IN THE 1990's

AREAS	SCIENCES	TECHNOLOGY
BIOLOGY	Recombinant DNA	Genetic engineering
	Cell Fusion	Plant cloning
		Microbial manufacturing
		Bio-electronic devices
PHYSICS	*Condensed Matter:*	*Microelectronics:*
	Semi-conductor properties	Semi-conductor devices
	Superconductivity	Room temperature super-conductors
	Superfluidity	Josephson switches
	Ferro-electricity	Bubble memory devices
	Surface physics	Extremely large-scale integration
	Phase transitions	
MATERIALS	Synthesis of new materials	New polymers
	Development of bio-polymers	New Metal alloys
	Liquid crystals	New materials with exotic properties
	Metallurgy	
ENERGY	Amorphous photovoltaic	Amorphous solar cells devices
	Photosynthesis	Biological solar cells
	Biomass energy conversion	Energy farms
	Energy storage	Synthetic fuels
	Plasma physics	Fusion reactor
	Breeding of energy plant	Geothermal plants
	Geothermy	Ocean thermal energy conversion
ENVIRONMENT	Ecology	Rehabilitation of damaged ecosystems

AREAS	SCIENCES	TECHNOLOGY
	Pollution	Waste recycling
	Global Climatology	Typhoon moderation
	Weather prediction	Weather modification
	Atmospheric modeling	Pollution control
EARTH AND MARINE	Geochemistry and mineralogy	Ocean mining
	Hydrology; water resources	Earthquake prediction
	Oceanography	Remote sensing
	Seismology	
	Mineral exploration	
	Marine geology	
LASER AND OPTICAL	Development of new lasers	X-ray lasers
	Coherent optics	Photography Optical Information Processing
	Non-linear optics	Fiber-optic communication
	Quantum optics	Laser surgey
	Integrated optics	Laser fusion
	Optical fibers	Industrial laser cutting
COMPUTER	Computer simulation	Optical computer
	Computer modeling	Voice-recognition computers
	New computer software	Super micro computers
		Talking computers
SPACE	Expansion of automatical observations	Shuttle technology
		Space manufacturing
	Solar activity and sunspots	Orbiting laboratories
	Lunar exploration	
	Planetary exploration	
CYBERNETICS	Artificial intelligence	Industrial robots
	Information theory	Computer-assisted learning
	Theoretical linguistics	
	Human perception/memory/ intelligence	
	Communications theory	
	General systems theory	
THEORETICAL PHYSCIS	Quantum gravity	
	Grand unification of the four forces	
	Cosmology	

AREAS	SCIENCES	TECHNOLOGY
	Gravitational radiation Better understanding of elementary particles	
MATHEMATICS	Algorithms Final classification of all finite simple groups Differential geometry Catastrophe theory Automatic theory	
MEDICAL	Better understanding of cancer and other diseases Greater knowledge about the brain	Immunication against other diseases
AGRICUL-TURE	Better understanding of plant diseases Plant breeding advances	Plant cloning Genetic control of plant diseases Biological control of pests and weeds Integrated crop and livestock farming systems

Glossary of Terms:

1. *Biology* is the branch of knowledge that deals with living organisms processes.
   1.1 DNA or deoxyribonuclei acid is recombinant when it exhibits genetic recombination properties.
   1.2 Asexually produced progeny is a clone. Plant cloning is the asexual reproduction of plant progeny
2. *Physics* is the science that deals with matter and energy and their interactions in the fields of mechanics, acoustics, optics, heat, electricity, magnetism, radiation, atomic structure and nuclear phenomena.
   2.1 Conductivity is the quality of living matter responsible for the transmission of and progressive reaction to stimuli; as the reciprocal of electrical resistivity, the higher the conductivity the greater the electricity or power which can be delivered.
3. Materials, like *polymers are chemical co*mpounds formed by a chemical reaction (polymerization) in which two or more small molecules combine to form larger molecules that contain repeating structural units of the original molecules.

4. *Energy* or energetics is the branch of mechanics that deals primarily with energy and its transformations.
    4.1 Amorphous photovoltanic relates to the utilizing of the generation of electromotive force when radiant energy falls on the boundary between dissimilar substances and the same has no distinct form or shape.
    4.2 Photosynthesis is the synthesis of chemical compounds with the aid of radiant energy or light; particularly the formation of carbohydrates in the chlorophyll-containing tissues of plants exposed to light.
    4.3 Biomass or amount of living matter in a unit area, volume of habitat the energy of which is transformed.
    4.4 Geothermy is the branch of energetics which has to do with the heat of the earth's interior; production of heat coming from the earth's interior.

5. *Environment* is the complex of climatic, edaphic (relates to soil), and biotic (relating to life) factors that act upon an organism or an econological community and ultimately determine its form and survival.

6. *Geochemistry* is the science that deals with the chemical composition of and chemical changes in the crust of the earth.

7. *Laser* is a device which utilizes the natural oscillations of atoms or molecules between energy levels for generating coherent electromagnetic radiation in the ultraviolet, visible, infrared regions of the spectrum.

   Optic refers to any of the lenses, prisms, or mirrors of an optical instrument.

8. *Computer* is any programmable electronic device that can store, retrieve, and process data.
9. Space is the region beyond the earth's atmosphere or beyond the solar system.
10. *Cybernetics* is the science or communication and control theory that is concerned with the comparative study of automatic control systems.

11 *Mathematics* is the science of numbers and their operations, inter-relations, combinations; generalizations, and abstractions and of space configurations and their structure, measurement, transformation and generalizations.
    11.1 *Algorithms* a procedure for solving a mathematical problem in a finite number of steps that frequently involves repetition of an operation; a step by step procedure for solving a problem or accomplishing some end.

12. *Medicine* is the science and art dealing with the maintenance of health and the prevention, alleviation, or cure of disease.

13. *Agriculture* is the science and art of cultivating the soil, producing crops, and raising livestock and in varying degrees the preparation of these products for man's use and their disposal.

Annex B to Privilege Speech of Senator Lina, Jr. on Science and Technology: Key to Progress and Accelerated Development (Source: 1988-1992 Philippine Development Plan and Technical Papers)

RESEARCH AND DEVELOPMENT PROGRAMS IN THE PHILIPPINES

AREAS	SCIENCES	TECHNOLOGY
HEALTH AND NUTRITION		Adaptation for Import *Substitution, Export, Local Market:* Biological reagents in local vaccine production for hepatitis, malaria, schistosomiasis Inexpensive drugs, hospital-based parenterals production (IV fluids) Fertility control Food supplements
		Modernization, Upgrading, Transfer Technology:
		Major diseases treatment Major health problem intervention Effective health delivery systems Use of praziquantel re schistosomiasis
AGRICULTURE AND NATURAL RESOURCES	Biotechnology tissue culture nitrogen fixation Bioengineering	Adaptation for Import Substitution, Export, Local Market:
		Wheat, soya production-experimental; high yield rice varieties Prawn, milkfish, tilapia and other aqua culture Efficient breeding, feeding, management for meat and milk Fish capture

AREAS	SCIENCES	TECHNOLOGY
NATURAL SCIENCES AND EMERGING TECHNOLOGIES		
BIOLOGY	Cell biology Microbiology Molecular genetics Tissue culture, cloning of plants Recombinant DNA	Biotic resources Ecology stressed tropical environment Marine resources Protein and other molecules design Coconut bioconversion Waste bioconversion Microbial-based techniques
PHYSICS	Laser Semi-conductor laser Field particle theories Tropical meteorology Physical Oceanography Optics	High power carbon dioxide laser Laser instrumentation Plasma Marine resources Dye lasers for chemical analysis Photodetectors Optical fiber communication system
CHEMISTRY	Organic Experimental Physical Biochemistry Analytic Inorganic Colloid Theoretical Chemical	Agroindustrial chemicals from indigenous raw materials Biologically active chemicals Fabrication of plastic, metal alloys High grade chemicals Polycrystalline, amorphous semi-conductor materials Instrumentation Liquid crystals, radio isotopes
MATHEMATICS	Algebra Geometry Discrete Statistics	
GEOLOGY	Mineral economics Engineering Volcanology Seismology	Crystalline nassifs Major basins Major mineral deposits Natural building materials Tectonic characteristics

AREAS	SCIENCES	TECHNOLOGY
TRANSFER TECHNOLOGY		Information system Financing schemes Commercialization of technologies Basic science education International linkages
		Modernization, Upgrading, Transfer Technology:
		Small, medium scale, cottage industry Carabao as draft Agro-forestry Agricultural wastes and byproduct Improvement of cereals, fruits, vegetables, legumes Inland water resources Resources management Mineral deposits discovery Nuclear techniques
		Adaptation for Import *Substitution, Local Market:*
INDUSTRY AND ENERGY		Local material substitutes for feeds, industrial minerals, basic industry chemicals, fuels New uses for abundant local materials; natural fibers; fast-growing woods and non-woods in furniture; Energy generation from waste agriculture, etc. Gasification systems

SCIENCE AND TECHNOLOGY IN THE PHILIPPINES: NO DEFENSE, NO OFFENSE, ALL MISSED FREE THROWS

Eduardo Pilapil
Congress of the Republic of the Philippines, House of Representative
Quezon City, Metro Manila

I must inform at the beginning that I am speaking in my personal capacity. My opinion does not reflect the official opinion of the House of Representatives, Congress of the Philippines nor that of its Committee on Science and Technology of which I am the incumbent Vice Chairman.

Thus, as I appear before a critical gathering like this one, I am experiencing the same trembling feelings as the idolater bowing before his idol somewhere in the thinning jungle in Asia and murmuring "I know that you are ugly, but I have no doubt that you are great and powerful."

I am conscious of the same experience before this international gathering of scientists and policy makers and administrators in government and private sectors. My affinity with science and technology is similar to relationships with a mother-in-law. Always discomforting but ever indispensable.

No National Plan for Science and Technology

The single, biggest problem of science and technology in the Philippines is the absence of a national plan. To be frank with you, science and technology is not even specifically identified as a priority subject matter or problem in our legislative agenda.

I believe that a national plan is essential so that we will know where we are and where we are going.

This absence was officially admitted in the July 1984 National Science and Technology Week by Minister Emil Javier of the National Science and Technology Authority, now the Department of Science and Technology, who because of that absence assured that he would work to make science and technology as tools to achieve the needs of society rather than be ends in themselves.

Two years later, in July of 1986, celebrating the same National Science and Technology Week then Science Minister, now Secretary Antonio Arizabal echoing the same problem stated that the immediate goal is to make the country enjoy fully the benefits of science and technology as a means of promoting economic development; the long term goal is to make the country's science and technology structure capable of taking quantum jumps to keep pace with the rest of the world.

He admitted that science and technology in the past has been neglected and because of that mistake the Philippines is now suffering in terms of poor scientific capability where it should be the leader considering that our country was first among ASEAN countries to make science and technology a major government concern with the creation of the National Science Development Board in 1958 by legislation per Republic Act No. 2067. This board by the way metamorphosed into what is now the DOST. He lamented that what advances we have are the production of impressive and beautiful brochures not understandable to the farmers and ordinary people and therefore a waste of resource.

That there is no National Plan on science and technology is further confirmed by our House of Representatives in House Resolution No. 187 referred to our Committee on August 26, 1987 and still pending further committee deliberations. Like the transfer of technology it really "takes time" and for our science community leadership, it is timeless and yet timely. This resolution directs "the Committee on Science and Technology to conduct an inquiry in aid of legislation on the status of Science and Technology said to be 100 years behind that of more advanced countries', in view of the rather low priority given to it by the government, and to recommend increasing budgetary appropriations for research and development and such other measures as may be necessary to give due recognition to their importance specially to a developing country like ours" on the following grounds and considerations:

1. science and technology in this country are said to be "100-years behind that of more advanced countries",
2. the Philippines spends about .2% of its Gross National Product (GNP) for research and development, although the recommended expenditures for such by the United Nations is 1% of GNP for developing countries like the Philippines;
3. it is said that there are only about 5,000 to 8,000 research and development workers in the country compared to almost 500,000 in Japan;
4. it is said that there are only a dozen recognized physicists in the Philippines despite the fact that a developing country like ours would need at least 1,000 physicists to have a self-sustaining mass of research activities in physics;
5. we cannot continue to lag behind the development of basic sciences including Biology, Chemistry and Physics;
6. there is an imperative need to conduct an inquiry into the status of science and technology in the country in order that the same may now be upgraded and given due priority by the government.

The said indictment is too clear to be misread and misunderstood. We are new, and, since 30 years past, open territory, defenseless and inviting and enjoying in total abandon.

One factor that defers the formulation of a National Plan is the low priority accorded to science and technology by the national leadership. In fact as confirmed by our committee findings there is no definite national policy on science and technology directions for the Philippines for the next 5 years. The lack of interest of our policy makers is shown by the dearth of proposed legislations on science and technology. During the first regular session which ended in June 1988 there were only five bills of national application filed, none coming from the Executive Department.

Luckluster R & D Performance

The urgency for a quantum jump in our scientific and technological capability is dictated, among others, by the glaring fact that our R & D program has no detectable inpact on our national economy as demonstrated by the perpetuating scientific and technological backwardness and negative growth rates in our agricultural and industrial sectors through the years. The perennial cause is the extremely low funding levels for more than 30 years. As is universally admitted, technology is developed and perfected only through R & D which activity is very expensive and time-consuming and therefore much depends on the national government for overall support and protection as well as the development of home-grown know-how and well-provided workforce.

A sector of our science community asserted that the deplorable and distressing R & D system, and ultimately the present backwardness of science and technology in the Philippines, are traceable to the following historical factors:

1. dependence on foreign know-how and inputs.
2. the predominantly sectarian educational system established by the colonial rule was elltist and hostile to the growth of a scientific culture.
3. bias for agricultural and medical sciences introduced during the colonial period and neglect of the physical science and engineering.
4. overall level of S & T development was hampered by the limited access of the masses to the English Language.
5. The S & T community is outside the main channels of decision-making in industrial development.
6. the trade policies imposed by the American colonial government hindered the industrialization of the Philippines by promoting the export of agricultural products and raw materials.
7. the educational policy imposed by the Americans were detrimental to the development of self-reliance in science and technology.

Our Unviersity of the Philippines Science Research Foundation confirming the foregoing assessments traced the country's economic and technological dependence around three major interrelated problems. First, the weakness of the country's scientific and technological potential. Second, the lack of effective demand for indigenous R & D and technological innovations and third, the almost total dependence of the country on importation of technology for its required means of production. To break this technological backwardness and dependence, new and bold economic and technological policy directions must be attempted and implemented.

Also proposed is the idea of "socio-economic command of technological development" that is, the ability of the entire society to control the direction of technological innovations in such a way as to maximize their social benefits and minimize their negative effects. That is not entirely easy since it would require the cooperation of every agency of government and most importantly a committed political will which is lacking.

Brain Drain

The lack of a committed political will and the unsystematic directions in our science and technology program provide convenient, if discomfiting, propellant for the costly dispersal of our rapidly thinning trained and skilled manpower resources. Our brain and brawn drain is now at its highest level. Like our balding forest cover whose destruction is the fastest in the world and which is estimated to evaporate in 10 years our brain and brawn drain is a world class record. The Filipino is everywhere in the world and his tribe is increasing as a domestic help, chambermaid, entertainer, mail-order bride, seaman, nurse, doctor, engineer, scientist, and other professionals.

Our National Science Foundation statistics admit that the Philippines lost an average of more than 1,000 scientist and engineers to the United States alone for the 10-year period covering 1966-1976 or 12,382 total. That figure must be higher and the destination points and expertise fields wider by this time. This sustained drain aggravates our backwardness and dependence because it dislocates our program for developing a stable and active research base. We export manpower and import technology but which exchange is obviously disastrous to us. I feel that this destructive situation will stay for so long as the whole scientific climate in the Philippines remains desperate and desolate. Our best physics institution alone is considered third rate by international standards and suffers comparison with those in Malaysia and Singapore.

Our government must now do something positive, assertive, definitive. We must do away with our outrageous confidence and correct the disorder in our science and technology system.

S & T being a vital and integral component of our economic development and self-reliant growth is really too important and critical an area to be left alone for too long to foreign interests. Our present crisis is traceable to this chronic state of mischievous dependency and scandalous complascency.

It is very disconcerting that despite official rhetorics and pronouncements, Constitutional and legal mandates, policy statements on science and technology even the simple manufacture of consumer goods are in the hands of foreign interest until now.

And there is no guarantee that even our discoveries will be used by our local industries considering that the big manufacturing industries which are controlled by multinationals are concerned merely with packaging, processing, assembling, marketing, financing.

Our experience demonstrate that this so called technology transfer is in reality a sale transaction involving technology and products. For instance, Philippine Refining Company founded in 1927 and Procter and Gamble-Philippine Manufacturing Corporation in 1935, are both manufacturing consumer products, but after 60 years no transfer of technology has taken place. Why?

Also, our then National Institute of Science and Technology (NIST) is recorded as having allowed technologies developed by its scientists to be utilized and commercialized by the sponsoring multinationals. This is "robbery" of our intellectual and natural resources in broad daylight and with government participation. To cite few: NIST has developed technology using local materials and plants for ingredients of products manufactured by Avon (Phil.), food flavors for Philippine Refining Company, dehydrated spices for Baymark Corporation.

I believe, we should not allow ourselves to be used in the service of these multinationals which are financially capable of engaging in their own R & D activities. We cannot take off under this inimical arrangements. These multinationals after getting the exclusive rights, pirate our scientists who develop the technology and then re-introduce the discoveries as transfer technology with the result that we are paying for what we developed. Our dependence gets rooted though the years by this exploitation.

We should be reminded about and keep at heart the admonition of a delegate from Pakistan in a similar conference held in Manila in 1982, who deplored the use of science and technology by developed countries for exploitative ends. The Pakistani delegate further admitted that dependence on foreign technologies has impeded the social transformation of the masses in Pakistan. That, likewise, has been the Philippines experiences ever since.

And also from the Chinese delegation in that same conference which cautioned against acquiring the most sophisticated and advanced technologies from industrialized countries, that developing countries in Asia must allow science and technology "to grow in harmony" with their socio-economic development, and that technologies for developing countries must require less capital investment, bring about quick returns, and be multi-purpose and easy to master. "In introducing foreign S & T we must emphasize the building up of our *own capability* in science and technology, never allow the transferring to hinder our own scientific research nor allow the total dependence on foreign technology."

S & T: The Key To Grow And Progress

For S & T to perform its vital role of being the key to the country's growth towards self-reliance, 3 factors must henceforth be considered.

1. adequate financial resources
2. proper national attitude (an overall reorientation of national character)
3. a strong political will

Adequate Financial Resources:

The amount of money that the national government will pump into the S & T budget will determine the degree of acceleration of S & T development in the country.

For it to properly develop its technical manpower resource base and strengthen its R&D capability, the S&T sector should be financially supported. At least 1% of GNP must be allocated for scientific and technological R & D expenditures. Aside from this, greater participation in R & D activities from the private sector is needed. Consequently close coordination and cooperation between government and private sector is necessary to properly monitor research activities.

National Attitude and Character:

A science consciousness must be cultivated among the people to create a receptive attitude towards scientific efforts by both government and private sectors. This demands an over-all cooperation from the people, government, the private sector and the scientific/academic community. Our students particularly must be motivated by a deep sense of nationalism to channel their talents, creativity and innovativeness and commitments towards a common goal of ultimately attaining S&T self-reliance for the country. Our professionals must be so imbued with nationalistic commitment so as not to be lured by better employment opportunities abroad.

Strong Political Will

Such dramatic change in national attitude and character towards S & T cannot be achieved without matching political will emenating from the very top. Only a strong political leadership truly supportive of S & T on both medium and long term basis can effect a genuine and independent science and technology policy.

Role of Legislative in S & T Development

Legislative support through passage of relevant bills/resolutions embracing education, industry, S & T institutions, research and development activities and technology transfer will be the conduit through which such political will supportive of S & T will be translated into concrete programs, strategies, projects, etc. These legislative acts must implement the Constitutional mandates for S & T to support national development plans toward self-reliance.

The Sub-committee on Oversight of which I am the Chairman will be concerned primarily with the investigation of the operation of the reorganized DOST and other government agencies involved. It will be interested in policies, programs strategies, organizational structures and the development of an efficient and effective piloting/commercialization network for local inventions.

The legislative agenda that the Sub-committee intends to pursue during the 1st half of the 2nd regular session of Congress will include the following:

1. Creation of a joint executive/legislative body on S&T
2. Creation of a national science center

3. Inclusion of the NAST representatives in the governing board of state colleges and universities
4. Determination of a priority program of each sectoral planning council in the Department of Science and Technology
5. Intellectual property-patents, trademarks, copyrights protection for Filipino inventions

On the other hand, on behalf of the House Committee on Science and Technology of which I am the Vice-Chairman the following recommendations are proposed.

1. That the President considers science and technology one of the top 3 priorities in the National Development Plan for the next 3 years with the appropriate budgetary support of at least 0.8% of GNP
2. That a continuing dialogue between the S&T Committees of both Senate and House and the Science sector be sustained
3. That the executive department provide policy measures for legislative enactment, to tap the resources of the private sector to complement government efforts
4. That legislative measures promoting self-reliance thru S & T be prioritized for enactment.

We are encouraged by the recent redirection and positive steps that have been taken by the new government and the science community in translating into realities the Constitutional mandates of an independent, self-reliant and competitive science and technology in the service of our people.

With the purposive political will and with your sincere and active participation on equal, equitable and cooperative conditions the Philippines shall soon be there in the forefront of the forthcoming Pacific Century, our Century.

TOWARDS A NATIONAL SCIENCE AND TECHNOLOGY POLICY IN THE PHILIPPINES

Ricardo M. Lantican
Undersecretary
Department of Science and Technology

Introduction

In many fora, the same question is repeatedly asked: Why has progress been so slow and distant in a country so endowed with natural resources and human resource potential? Progress and economic well-being have indeed eluded us, what with 59 percent of our 57.4 M population living below the respectable level, an unemployment rate of 11.2 percent in 1987, and a government deficit spending owing to the channeling of a large share of our national budget to foreign debt servicing.

By contrast, our Asian neighbors, Taiwan, South Korea, Hongkong, and Singapore have been able to forge ahead and attain a newly industrialized status and are now enjoying their unprecedented rise in economic power in the Asia-Pacific region.

Where lies the gap? What seems to be the reason that prevents us from keeping our targets? How does science, being the most powerful force that have shaped the destinies of developed nations, come in to get us out of the bind?

Recently, the government in its bid to propel the economy into a complete takeoff, has clearly enunciated a development agenda that hinges on sound policies for the next five years, and a long-term strategy for economic development, productivity and sustained growth.

But first, let us consider the economic and social backdrop under which S and T efforts are to operate. The country's population is expected to reach 63.11 M by year 1992 with a yearly increase of 2.4 percent. This would mean 5.7 M more than our present population or an additional 1.377 million people each year. Our 23.6 M labor force is estimated to go up to 26.8 M by 1992. If our economic program would have to work, it should be able to provide jobs for about 798,000 new entrants to the labor market. Conversely, the rate of unemployment would have declined from 10.6 percent in 1988 to 4.6 by 1992. The annual GNP growth for the period 1988-1992 is placed at 6.5%. Likewise, the yearly average family income of $600 is expected to increase substantially to $1000 by year 1992. What more, the 21st century is upon us and we have to gear up for the new challenges.

But how do we attain these targets? It is believed that the advances and application of science and technology are crucial if the country is to rapidly industrialize and progress. It is evident that through the effective infusion of science and technology, the newly industrialized countries were able to attain an economic growth rate of around 10%. If we can do the same, we can probably increase our target beyond the 6.5% annual growth rate.

The Department of Science and Technology

At this point, it would be worthwhile to look into the science body that has been mandated to take a lead role in the national development of science and technology.

As you are aware, the Department of Science and Technology (DOST) is the national organization that oversees the development of science and technology in the Philippines. It makes policy initiatives, sets directional goals in research and undertakes coordinative functions in program implementation.

The development of the national science body has undergone transformation in organic structure and mandate over the years, in response to the increasingly important role that science and technology is expected to play in socio-economic development.

In 1958, Congress enacted a piece of legislation, the Science Act or Republic Act No. 2067, which created the National Science Development Board (NSDB). The science body was mandated to promote scientific and technological research and development, foster inventions and application of scientific knowledge as an effective instrument for the promotion of national progress. A national infrastructure for science and technology was built. Grants-in-aid for research and development were made available to established research institutions and new science insitutions were established.

In the late seventies, the concept of mission orientation in S and T program was introduced. The issue of relevance and high impact of S and T programs were beginning to be seriously discussed. The need for more focused efforts to provide solutions to specific societal problems was addressed. The social, economic, and even at times political implications of S and T programs were examined and subsequently comprehensive programs were formulated.

Then on March 17, 1982, the NSDB was further reorganized under E.O No. 784, to become the National Science and Technology Authority (NSTA) in order to further intensify R and D, expand the scope of its functions and make it more responsive to the needs of the economy. The major policy that was advocated and still pursued to this day was the demand-pull strategy. Contract research between the government research agencies and the private sector industries has become an essential feature in pursuing R and D.

With the advent of the new Government and cognizant of the need to immeidately resolve pressing social and economic issues, much is expected from science and technology in providing the answers.

Thus, there have been significant pronouncements and strategic moves on the part of the government to re-inforce the role and functions of the science body. These significant developments are:

1. Declaration of principle and state policies in the 1987 Philippine Constitution (Article II, Section 17 and Article XIV, Section 10 to 13) recognizing the pivotal role of science in accelerating social progress and national development;

2. Elevation of the science body into the Department of Science and Technology level with the head (Secretary) assuming full cabinet rank;

3. Institution of the reorganization process as mandated in E.O. No. 128 dated 30 January 1987 which expanded the scope of coordinative functions of DOST to include among others, the field of advanced sciences and technology.

The S and T Plan

The Medium-Term Philippine Development Plan, 1988-1992, has been updated very recently and the chapter on science and technology is a collective effort among representatives from agencies in the science and planning community and private sector.

The plan was conceived in consonance with the state principle on reliance on science and technology as the means to achieving the immediate as well as the long-term needs of the country.

A. *Objectives*

The primary objective of S and T shall continue to be the provision of substantial scientific and technological inputs to realize national development objectives. Indigenous, appropriate, and self-reliant scientific and technological capabilities shall be developed and their application to the country's production systems and national life emphasized. S and T activities shall address the employment-oriented, rural based strategy for development. Science and technology shall be harnessed to substantially contribute to increased economic growth and improved quality of life.

Specifically, the objectives of the S and T sector are the following:

a. To generate and upgrade technologies appropriate to the needs of the production and social services sectors;

b. To utilize indigenous and imported technologies to help increase the growth and productivity of the production and social services sectors;

c. To improve the selection, assimilation, adaptation and diffusion of appropriate imported technologies;

d. To develop and upgrade the national scientific and technological manpower, financial, information, and institutional capabilities; and

e. To develop the national infrastructure for advanced science and technology and ensure the country's economic viability and technological competitiveness in the 21st century.

B. *Highlights of S and T Chapter – Medium-Term Development Plan*

The science and technology sector during the current plan period strongly emphasizes the transfer and commericalization of technologies. An objective to this effect has been explicitly stated apart from simply the generation and upgrading of technologies with high economic impact and employment generating potentials. Linkages between the Department of Science and Technology and other line departments as well as the private sector shall be strengthened to accelerate the flow of technology from the S and T sector to the other sectors. The active participation of non-governmental organizations and other institutions in bringing technology particularly to the rural areas shall be encouraged.

The S and T sector recognizes that competence in the advanced fields of science and technology is considered necessary if the country is to make the quantum leap as a newly industrialized country by the year 2000 or thereabout. To ensure the country's economic viability and technological competitiveness in the 21st century, a national infrastructure for advanced science and technology shall be developed. Scientific and technological capabilities including high quality manpower shall be built in growth areas which offer vast opportunities in the near future. These areas include biotechnology, microelectronics, materials science, computer and information technology, and new energy sources. A comprehensive plan that integrates manpower development, institution building, and research and development (R & D) programs in the said areas shall be implemented.

A system of indicators for science and technology has been adopted to effectively monitor the progress of S & T development. A number of measures are used in addition to such indicators as national expenditures for science and technology specifically research and development, number of R and D professionals, and number of science and mathematics teachers. Among the measures of efforts to generate and utilize technology are: number of patents granted to local inventors with special attention to those directly commercialized; number of manufacturing firms with R and D units. On the mastery of imported technology, an informational system to closely monitor relevant activities shall be made operational. The focus shall be on relevant information pertaining to technological adapatation, modification and innovation made on imported technologies.

S and T expenditures are targeted to reach 1.5 percent of the gross national product by 1992, increasing at a slower rate in 1988 and 1989 but hopefully to accelerate during the remaining years. The number of local R & D scientists and engineers shall also be increased by 50 percent.

With the approval and implementation of the S and T Incentives Bill pending in Congress, the private sector is expected to increase its share of local R and D work from 15 percent to around 50 percent of national R and D expenditures.

In the area of advanced S and T, new centers of excellence are being proposed. It is targeted that in the natural sciences, there shall be an additional 310 masteral graduates with specialization in the advanced S and T areas and 32 in the Ph.D. level by year 1992. In the engineering sciences, 80 graduates are expected at the masteral level and 10 in the Ph.D. level.

Specific policy statements have been formulated to stress the added concern for the effective management of technology and the preservation of the quality of the environment. Special attention is also given to the further development and upgrading of the S and T infrastructure. The national S and T manpower, financial, informational and institutional capabilities shall be strengthened to develop a national S and T potential for self-reliant innovativeness and mastery of selected foreign technologies.

Sectors Addressed and Strategies

The policies in S and T are directed to the needs of the six sectors considered important, these are:

1. Agriculture and natural resources
   - Agricultural diversification and rural productivity through the development of improved but low-cost production and post-production technologies; development and upgrading of livestock; and development of integrated and small-scale forest and agroforestry production schemes for marginal lands.

2. Fisheries and aquatic resources
   - Sustained yield of fisheries and aquatic resources through improved management and development of coastal, inland marine fisheries; development of local substitutes for imported production inputs; and upgrading of cultured species.

3. Industry and energy
   - Enhanced industrial productivity and competitiveness through the conversion of local materials to higher

value products; development of import substitutes for materials and products; development of non-traditional/agrobased products for exports; and development of capability for machine building and parts manufacturing.

- Self-reliance in energy, utilities and infrastructure through the development of alternative non-conventional energy sources; and development of materials, components and standards for the transport, communication and construction industries.

4. Health and nutrition

- Improved health and nutrition of the population through the development, production and utilization of drugs from indigenous sources, generation or adpation of technology focused on specific health problems; development of food formulations and policies to improve the national nutrition status; and improvements on the health services delivery systems.

5. Natural sciences and emerging technologies

- Development of a national infrastructure for advanced science and technology through strategic research in such fields as microelectronics, biotechnology, materials science, information technology, and new energy sources.

6 Environmental and natural hazards

- Improved methods of predicting the occurrence of natural and environmental hazards through the generation of basic knowledge and expanded data base of such occurrences.

Some favorable features of S and T infrastructure in the Philippines

1. Recognition of the role of S and T in national development as enunciated in the 1987 Philippine Constitution;

2. Elevation of the science body into a Department level bringing science closer to developmental planning and executory functions of government;

3. The reorganization process has expanded the coordinative functions of DOST to address other areas like the advanced sciences thus enabling the science community to meet the challenges of the 21st century;

4. The strong coordinative mechanism of DOST over different R and D bodies in the country through the Sectoral Council systems;

5. Creation of an office, the Technology Application and Promotion Institute, which liaises between the science community and the private sector, and which would undertake contract research particularly at the pilot plant and semi-commercial stage and provide technical consultancy including engineering design services, patenting and licensing services; provide grants and venture financing for new and emerging projects;

6. The establishment of Regional Offices in 12 administrative regions of the country which would enable the DOST to reach out at the grassroots in coordination with line departments, local governments, and the private sector in the regions. The regional offices also provide feed-back information to the Research Institutes and Sectoral Councils of the DOST System with respect to regional needs and appropriateness of new technologies being introduced.

Elements that have helped speed up the developmental process in some countries toward achieving the newly industrialized status

At this point, let me make a listing of some of the factors that have stimulated the developments of the newly industrialized countries, in the hope that we can make some comparative analysis with the Philippine situation.

1. Development of a strong science policy, and S and T infrastructure as well as a political will to harness S & T and instrumentalities of government towards accelerated development;

2. Creation of high level policy-making body such as a Council for Science and Technology with the Head of State as Chairman;

4. Availability of comparatively cheap but highly skilled labor;

5. Mastery and improvement in the use of borrowed technologies, initially to manufacture goods as import substitutes and later to establish a comparative edge in the export market;

6. Development of manpower capabilities in S & T work and a strong work force of technicians and technologists in the industry sectors;

7. Heavy governmental and private expenditures on R & D;

8. Emphasis on "product development" and less emphasis on the more basic research;

9. Strengthening of the agricultural base economy as a staging off point towards industrialization; and

10. Development of a strong science culture among the population.

Perceived gaps and initiatives needed to strengthen S & T in the Philippines

1. Many people have expressed the view that there is a need to have high level S and T policy-making body in the Philippines, similar to those in other countries, to be headed by the President of the Republic. Such body will coordinate the efforts of line departments and instrumentalities of government towards the attainment of prioritized S & T goals in development. Of course, there is already the NEDA Board which could probably exercise the same functions but at present the Secretary of DOST is not a member of that Board.

2. The budgetary allocation for R & D work in the country is less than 0.2% of the total GNP and efforts must be exerted by the national government to increase it progressively to an equivalent of 1%. Much financial resources are needed in upgrading and modernizing laboratory facilities, increasing R & D capabilities and providing a comprehensive reward system to scientific personnel .

3. Private sector contribution to R & D is not very significant. Legislation is necessary to provide the needed incentives for the private sector to engage in R and D activities. Senate Bill No. 242 or the proposed S and T Incentives Act for private sector addresses this gap. This bill aims to provide tax deductions for R and D expenses and R and D loan privileges.

But more importantly, a strong political will is imperative in order to translate all these target statistics into concrete social realities. Unless we come to grips with this problem, we are likely to make ill-advised decisions about the future.

Hopefully and with support from the national leadership, we could fully harness science and technology to effectively contribute to the national economy and well-being of the people.

A SCIENCE POLICY FOR THE PRIVATE SECTOR

Maneleo Carlos, Jr.
President, Resins, Inc.

Good afternoon. Distinguished personalities in the head table, distinguished guests, delegates to this international conference, ladies and gentlemen.

I have been asked to represent the private sector views over science policy for developing countries. I would start with premise that most developing countries which aspire for accelerated development must designate the private sector to be their mean tangient for growth.

Therefore, I have the title of my presentation as reminder that good science policy must benefit principally the private sector.

A study of the industrialization of countries will reveal that greater economic progress is achieved when the science and technology program of the country relate to its various economic activities. A closer look will probably reveal also that the amount of scientific effort and expenditure alone are not enough to guarantee economic progress. Rather, it is evident that science and economic policies and program must be coherent and related in order that scientific findings can readily become economic realities.

Having said this, I would now like to touch on the various elements that a comprehensive policy ought to consider from generating science and technology up to the investments that must follow.

To begin with, most developing countries have a good core of scientists and technicians to start R & D programs. What is often lacking are the research infrastructures and support facilities for them to undertake programs efficiently and effectively. For example: laboratory supplies are often lacking, forcing the researchers to compromise the quality of their work or to lose time waiting for importations to arrive. What would take their counterparts abroad just 24 to 48 hours will take them as long as three months.

You can imagine the delays and the frustations that arise. What is needed, therefore, are supply houses to operate with complete inventories at the least cost possible foregoing taxes and tariff duties, and if necessary by providing direct subsidies from the government.

Another detrimental factor is the inadequacy of library facilities and the absence of worldwide and even domestic literature search capabilities due to inadequate communication networks.

As a result, our scientists spend more time yet with poorer results in their surveys than their computer-aided counterparts abroad. Such lack causes the waste of valuable man hours that could be more productively engaged.

I see no remedy to this difficulty outside the more direct budgetary support for all these specific needs that I have mentioned.

With the growing complexity of both scientific knowledge and scientific processes, strong science communities are becoming necessary. Here, a certain amount of synergy developes that makes the community much much more productive and fruitful.

In the Philippines, we have these communities in Los Banos, Bicutan, Diliman, and Ermita. But admittedly, they are very small in numbers, too thinly spread and with no private sector involvement.

We need to attract more of our scientists presently working abroad as guests or returnees to help create that critical mass necessary for significant breakthroughs.

Scientists will return if the community environment is progressive and productive, and will continue to enhance the professional development.

One factor in favor of developing countries is the fact that we can more readily provide the staff support for their brains and skills. It would do well to our planners and policymakers to visit the scientific communities abroad, to copy the good point that they are doing and to recommend the programs that will attract back our scientists, as well as to arrest the continuing brain drain.

I believe that this hemorrhage will only slow down when the level of scientific activity increases significantly. And that may well mean, until the private sector becomes a substantial participant in research and development.

Another area which involves the joint efforts of these science communities with the private sector is in preparing the long-ranged programs for scientific research.

While this is in the realm of the advanced countries, there is also a need for developing countries to do some work in advancing science in the areas where their economies may benefit from comparative advantages.

The idea of providing fiscal incentives for R & D has also been discussed often. The stated objectives is to encourage more scientific effort to be undertaken especially by the private sector. However, what must be recognized is the likely difficulty of administering such a program of fiscal incentives, like income tax holidays, because of the confidentiality and complexity of evaluating research. Instead, let me suggest the ways to encourage the private sector to undertake more research as follows:

1. reduce the cost of undertaking research
2. improve the chances of success, and
3. reward successful research or technology transfer

First, the cost of undertaking research can be markedly reduced by encouraging the practice of joint or contract research with the government's institute of science and technology. If the private enterprise is not yet undertaking any research on its own, this is an excellent way of leading him into this activity, and possibly training its management and staff in the process.

Even when the enterprise had undertaken R & D work, contract research can still provide cost reduction benefits.

Second, R & D by its very nature entails significant risk of failure, however, the chances of success can be enhanced by appropriate doses of technology transfer. And there is very good reason to encourage rather than discourage this practice. In fact, it is a good policy to adapt the best applicable technology as a way to leap frog and catch up with the developed world. The corollary to this is that we must discard the notion that the use of indigenous technology should inhibit consideration of more appropriate foreign technology.

A review of how each of the developed and newly industrialized countries adapted foreign technologies selectively will prove the validity of this policy.

We must also realize that the imported technology can provide a very good stepping stone for the development of local technology. And in fact is the only way we can stay in this economic progress.

Incidentally, since foreign technology usually goes to the private sector, this is an area where private enterprise can contribute significantly to the national store house of science and technology via a reverse transfer of its knowledge to our science community wherever possible or allowed.

There are other variants in the transfer of foreign technology . One, can be through cooperation with other foreign research organizations. Another is through guest scientists being invited with their wealth of knowledge and experience.

The third point, to encourage private sector into research is to reward successful research and technology development.

Here, most of the rewards I advocate are through fiscal measures. A successful research for technology to be transferred requires capital investment in pilot and then commercial plant facilities. Both usually require considering more capital than the research effort.

The government can recognize this more significant risk by providing fiscal incentives in the following areas:

1. The capital costs should be allowed tax and duty free benefits so that the costs are minimized.
2. The total investment should enjoy the most rapid write-off or depreciation so that the investor may recover his capital cost as early as possible, and
3. Similarly, improvements in the facilities should be written-off rapidly in order to encourage changes whenever deem attractive. This particular feature will encourage the enterprise to innovate continuously in order to constantly upgrade its quality and productivity.

Essentially, science and technology are simply the means or the processes to attain economic progress, unless or until these are applied to economic activities, it will remain value-less.

On the other hand, we recognized that new technology generally means more risks for the capital investments that must follow.

It is in recognition of these risks that the government should promote such investments for fiscal measures.

Corollary to this, I conclude that one of the most effective ways to promote science and technology is through a policy that links the private and science sectors, and that fosters and supports innovations in all of our economic activities. This is the best way to keep our private sector competitive in the quality and cost of their goods and services. Thank you very much.

SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT IN INDONESIA AND THE PLAN FOR THE ESTABLISHMENT OF A NATIONAL ACADEMY OF SCIENCES

Sabana Kartasasmita
Assistant Minister of State for Research and Technology
Indonesia

Progress and prosperity achieved until recently in many parts of the world is a result closely related to the development and role of science and technology. However, the role and benefit of science and technology still could not be felt and enjoyed by the entire population of the world. Even during the last two decades it is being felt more and more that spectacular developments in the field of science and technology with great impacts in many fields still widens the gap between the more developed industrial countries in the North and the developing countries in the South. More than 90 percent of the investment and more than 80 percent of the R&D capacity of the world is situated in the North, and only a small fraction of that capacity is directed in solving the problems of the majority of population in the South. Moreover, the total production of industrial goods from all the countries in the South accounts only for 10 percent of the total world production. A more conceptual approach and common basic strategy among the developing countries is then imperative in bridging the gap. A gathering organized by the National Academy of Science and Technology of the Philippines and the Federation of Asian Scientific Academies and Societies (FASAS) like this one held in Manila could contribute in identifying common problems and common objectives in the region.

Now, referring to the development of science and technology in Indonesia, this could not be separated from its historic past and the development of science and technology in the world today, so that its development could be described as an interaction between the present international trend and its historic developments.

Based on its historic developments since time immemorial the Indonesian people have acquired the knowledge to master the seas, cultivate fish in ponds and fish farms, cultivate rice, cloves, pepper and nutmegs, build huge temples, develop damascene for krises, formulate herbal medicine, and in various other fields as well. All of those are acquired in a more traditional way.

Interaction and interference with Western and other foreign culture brought by visitors, traders and colonial powers in the past develop and systemize those knowledge into the present scientific and technological base on which our development is based.

A rather systematic application of sciences notably in the natural, cultural and social sciences has already been started in Indonesia during colonial times by the creation of the "Botanic Gardens" in Bogor, West Java in 1857 and the founding of the "Bataviaasch Genootshap Voor Kunsten en Wetenschappen" before the end of the 19th century. It is for their political interest that the Dutch colonial rulers at that time promote the development of sciences in the Netherlands East Indies. Activities in these fields has created renowned Dutch scientists in the international level, especially in natural sciences, social sciences and medicine.

It is therefore also obvious that for the above reasons scientific activities is directed on the national level already by the Dutch Colonial Government. A number of major activities in the fields of natural science have been initiated under auspices of the "Natuurwetenschappelijke Raad Voor Nederlandsch Indie" (Council for Natural Sciences of the Netherlands Indies), and one of its noted activity is the hosting of the Fourth Pacific Science Congress in 1928. Since then the Organisatie Voor Natuur Wetenschappelijk Onderzoek" (Organization for Research in Natural Sciences) is taking over the role until Indonesia is gaining independence in 1945.

Independence thereafter gives us the opportunity to maintain the high standard of scientific tradition already started during colonial times. To face that challenge and even with limited indigenous scientific base with the Act No. 6. in 1956 a Council for Sciences of Indonesia was established with the main task to promote scientific activities, scientific awareness and scientific development in general in the country. The Council is also being assigned to pave the way for the establishment of an Academy of Sciences in the future.

Since there was a great need at that time, the Council in 1960 also established a number of national laboratories and research institutes in the fields of natural sciences, technology and social sciences and a national scientific documentation centre.

After the establishment of the Department of National Research in 1962 the function of the Council for Sciences of Indonesia is placed under the guidance of the Minister of National Research.

The confusing situation during the old order in the mid-sixties also has an influence on the development of scientific institutions in the country. The short lived Department of National Research was demoted to the status of a National Research Institute.

The evolving new order which is based on a more institutional and constitutional approach in the conduct of national affairs, through a Decree, the People Consultative assembly abolished both the existence of National Research Council and the Council for Sciences of Indonesia, because of their similar functions. By a Presidential Decree No. 128 dated August 23, 1967 the Indonesian Institute of Sciences was established, to continue the functions and tasks of directing and coordinating scientific and technological development in Indonesia. As a continuation of the role of a Minister of State for Research which was appointed in 1974, a Minister of State for Research and Technology was appointed since 1978 to give guidance and direction in research and technological programs in the national level, the operational coordination of the non-departmental agencies such as the Indonesian Institute of Sciences, the National Atomic Energy Agency, the National Coordinating Agency for Survey and Mapping, the National Aerospace Institute, the Agency for the Assessment and Application of Technology and the National Bureau of Statistics.

Since scientific and research activities are being conducted by almost any other agency and institution in the country, there exists some kind of conventional division of task and direction of research. Scientific research in universities which is under the auspices of the Department of Education and Culture e.g. is directed towards basic research in relation to the development of general theories which are mostly curiosity based and universal in nature. Some of the results of university research is then utilized in the applied sectoral research of various departments. A function to bridge basic research in universities and applied research in the departments is being conducted in the non-departmental agencies, the research activities of which mostly are long-term in nature, cross-sectoral, interdisciplinary, strategic and mission oriented.

Since the start of the First Five Year Plan (Repelita I) in 1968/1969 the Government of Indonesia has taken an important role in attempting to reinforce the scientific and technological component of development. Priorities have been given toward upgrading R&D institutions and the upgrading of scientific and engineering manpower. When in the early stages programs are focused on the agricultural and food and raw material processing sectors, lately more attention have been directed to the technology component in the heavy and light industries. In the ongoing Repelita IV (1984-1989), high priority is given to upgrading the so called "linkage industries" such as casting, heat treatment, sheet metal work, welding, plating, machining, presswork, equipment repair and design engineering. The forthcoming Fifth Five Year Plan (Repelita V) is then viewed as the final stage in establishing the framework for the "take-off" of the Indonesian economy toward the 21st century.

As mentioned earlier, several government agencies are involved in formulating and implementing national policies for sciences and technology, including R&D programs for national development. In addition to the National Development Planning Agency (BAPPENAS), the Minister of State for Research and Technology coordinates all research and technology activities in the government sector. The Research Centre for Science and Technology (PUSPIPTEK) in Serpong operates several laboratories and research centres that service the scientific and industrial communities. These include facilities in the fields of calibration instrumentation and metrology; electrotechnical; applied physics; applied chemistry; applied metallurgy; construction testing; thermodynamics, engines and propulsion systems;

aerodynamics, gasdynamics, and vibration; natural resources and energy; process technologies; natural disaster mitigation; a sciences demonstration centre and a multipurpose reactor. The agency for the Assessment and Application of Technology (BPP Teknologi) is responsible for controlling and assessing the impact and acquisition of industrial technology in national development. The National Research Council (DRN) which was established in 1984 as an advisory body to the Minister of State for Research and Technology has been designated as the agency to integrate all scientific and technological activities in Indonesia, including evaluation of ongoing national programs for research and technology, and formulation of new programs. So far priority subject areas have been formulated as Principal Programmes in Research and Technology for Repelita V in the respective fields of basic human needs; natural resources and energy; industrialization; defense and security; and social, economy, culture, philosophy, law and legislation.

The Minister of State for Research and Technology, Dr. Habibie has been highly instrumental in directing the role of the state in advancing science and technology in support of industrial development, especially the infusion of technology into selected industrial sectors which are a precondition to expanded growth for a more productive output.

Alongside with the development of science and technology in Indonesia as described earlier, the plan for the establishment of an Academy of Sciences is also taking momentum. To expedite the process for the realization of the establishment of the Indonesian Academy of Sciences, the Minister of State for Research and Technology in 1984 has setup an Interdepartmental Committee to formulate the function and task of such an Academy and formulate the draft of an act for its establishment. Its membership constitutes representation from different profession from various agencies, institutes and universities. The Committee was chaired by the author in his capacity as Assistant to the Minister of State for Research and Technology for Institutional Affairs. Consequently the Committee took over the task which was originally assigned to the Indonesian Institute of Sciences as a result of the abolishment of the Council for Sciences of Indonesia in 1967.

After a lengthy and vigorous deliberations and consultation among the respective parties the Committee in 1985 finally presented a final draft of an Act for the Establishment of the Indonesian Academy of Sciences. The Act comprises various chapters and articles dealing with general provisions, status, objectives, main tasks and functions, membership and other provisions.

The Indonesian Academy of Sciences basically will be a non-structural independent and highest organization in the field of sciences and shall be responsible to the President of the Republic of Indonesia. Its objectives will be to have the task to develop sciences in general to meet national objectives. It will also have the task to advice the government and the legislative and judicial bodies and to give counsel to society on the guidance and development of sciences in Indonesia.

In order to implement the tasks mentioned before, the functions of the future Indonesian Academy of Sciences will among others be: (a) to formulate the long-term basic strategies in the fields of science policy and development in the country;

(b) monitoring activities, development and growth of sciences at home and abroad; (c) to review and evaluate the development of sciences based on academic freedom; (d) to give advice to the government on the direction of scientific development, including the policy and priority of its development; (e) to give counsel to society as part of giving solution to scientific problems prevailing in society; (f) assist government scientific agencies in its effort to achieve science mindedness in Indonesia. It is also envisaged to expand this academy with an Academy of Engineering and an Academy of Medicine in the near future.

It could be reported that at present the draft of an Act for the Establishment of the Indonesian Academy of Sciences is undergoing final scrutiny by the State Secretariat before submitting it to the People's Representative Assembly (Parliament) for adoption and enactment. It is generally thought that with the establishment of a National Academy of Sciences the development of a balance and viable scientific and technological ecosystem in Indonesia is then complete.

Aside from global issues prevailing nowdays, Asean countries in particular are faced with several common problems, the remedies of which if jointly undertaken could lead to meaningful results, a common conceptual approach, collective efforts and mutual cooperation among each other is highly desired.

It is therefore very imperative that modalities of cooperation among scientific academies and societies to collaborate with each other to work for national and regional development should be pursued and enhanced.

INTERNATIONAL CONFERENCE ON SCIENCE POLICY FOR DEVELOPING COUNTRIES

Prof. M.O. Ghani
President, Bangladesh Academy of Sciences

Let me, at the outset, express my cordial thanks to the Philippines National Academy of Science and Technology for inviting me to attend its 10th anniversary celebrations and also to participate in the deliberations of the International Conference on Science Policy for Developing Countries arranged on that occasion. I am happy to be here among many distinguished scientists who have come from different parts of the world, both developing and developed. I am not a stranger, however, in this beautiful country of yours. My first visit to the Philippines was in 1956 to attend the South East Asia Soil Science Conference held in this city, as a representative of UNESCO, which gave me an opportunity to take part in extensive tours of the country right up to Bontok in the north. My last visit was to attend the 10th anniversary celebrations of the International Rice Research Institute (IRRI) at Los Banos in 1972. In between, during 1966-70 when I was a member of the Board of Trustees of IRRI, I made frequent visits to Los Banos and also some parts of the countryside to see the spread of HYV rice and agricultural development in general. I am, indeed, very glad to be here once again after about 16 years.

Dr. Paulo Campos, President of NAST in a cable last month requested me to speak at the Plenary Session of this conference, throwing some light on the recently formulated science and technology policy of Bangladesh.

I need not repeat the oft-repeated words that science and technology are key factors and crucial determinants in the socio-economic development of a nation. That culture of science along with its offspring, technology, is the most powerful instrument of change in the quality of life of the people is now universally recognised. It is also recognised that the widening gap in the progress and prosperity between the developed and developing countries is largely attributable to lack of conscious and determined efforts on the part of the latter in using this instrument of growth for fuller exploitation of their natural and human resources. Happily, during the last three or four decades, this awareness has gradually dawned in the perception of the developing countries though in many of them, classed as less or least developed, progress has been slow and poor entailing acute poverty and deprivation of the basic needs of life for the majority of their people. That inadequate financial investment for science and technology is a major factor, there is no doubt about it. The developed countries spend about 10 times more of their Gross

National Product (GNP) for scientific research and development as compared to the average spending of the developing ones and often the development gap is equated with the order of spending. Yet there are developing countries within the range of spending of 0.2 to 1.0 per cent of GNP roughly, that have made remarkable advances in the use of science and technology, as reflected in the development of their industry, agriculture, trade and commerce, etc. Examples are South Korea, India, China, Brazil and a few others. This differential would seem to be due to strong political will coupled with a well-conceived science policy translated into action through comprehensive and coherent plans, programmes and projects. Poverty and non-development, in my view, form a vicious circle which can be broken not by resources alone but equally by the resourcefullness and determination of those on whom is reposed the task of formulating a national science policy and based on it, realistic plans and programmes and their proper implementation. For a developing country, a science and technology policy document giving broad guidelines and indicating thrust areas for national scientific endeavours cannot, therefore, be over-emphasized.

Before I make a brief reference to the recently formulated Bangladesh Science and Technology Policy, I would say a few words about certain basic considerations that went into it in order to make it viable and constructive. Firstly, the S & T policy and plan must be an integral part of the overal national development policy and plan and conform to its broad objectives, goals and priorities identified for the various national economic sectors concerned and involved in the use of science. Secondly, policy making and planning functions should not be separated from each other. In fact, formulation of a policy by itself will not guarantee its translation into practice unless it is backed by a sound and comprehensive plan of action made in the true spirit of the policy just as, however sound may be a plan, it will be of no real avail if not implemented effectively. I lay emphasis on this obvious point because in our experience very often sound policies enunciated in various national spheres have failed to realise their objectives due to inefficient and inadequate implementation which again may be due to over-decentralization of monitoring functions. It was, therefore, considered essential that these three functions of policy making, planning and monitoring should rest with a single high powered national body representing all relevant interest such as politicians, administrators, planning experts and scientists. Thirdly, there must be firm Government commitment to provide the financial resources on a continuing basis to achieve the plan targets.

In addition, in order to bring about rapid transformation in the development scenario with limited financial resources, the R & D programmes in the various sectors need to be trimmed, by curtailing less important and less urgent items of general nature and concentrated on those only that may generate significant thrusts on the major national problems in agriculture, industry, energy, health, environment, etc. Fundamental research and some items of basic research, as may be needed by the R & D institutions, may be left with the universities under a cooperative arrangement. Again, to ensure that scarce resources are put to full use in time-framed, goal-oriented R & D programmes, the plans must have a built-in mechanism for accountability all along the line of command from research institutes, laboratories and centres, down to the lowest operating units. To this end, the plan must provide for realistic appraisal of successes, failures and shortcomings relative to the human, physical and financial resources gone into them so that prompt measures may be taken to remedy the defects and revamp the process and if necessary, to revise the policy element. The major components of plans in developing countries will, of course, have certain common functions such as development of trained scientific and technical manpower, institutions, information systems, indigenous technology and improvement of standard of scientific knowledge at all educational levels, though the detailed plan may differ from country to country in its character and strategy under varying economic, social and cultural context and national endowment factors.

The process of having a national science policy in Bangladesh has gone on since the beginning of this decade. And in this exercise Bangladesh Academy of Sciences in its advisory capacity has acted as an important catalyst. In 1980, the Academy in a national seminar titled "Science, Scientists and Society" went into this matter in some depth and by general consensus of the scientific community of the country recommended a two-tiered policy making and planning machinery, namely, a Cabinet Committee headed by the President of the country and a National Council headed by a scientist. Its recommendations in a printed form were widely circulated to concerned authorities and scientific circles. I may mention that the Academy has all along advocated more effective say of scientists in science policy matters. Later, in the same year (1980) the S & T Division of the Government formulated in undue haste a National Science and Technology Policy which had to be given up as it was found lacking "in definite guiding principles and any effective mechanism even for partial implementation of the policy".

In 1983, Government formed a National Committee on Science and Technology to perform a number of functions, the most important of which was to "recommend national policies on science and technology". The committee was headed by the President of the Republic and had in its membership Ministers, Departmental Secretaries and eminent Scientists. This committee took up the task of framing the S & T policy in right earnest and finally circulated a draft policy statement of scientific organisations and such non-governmental bodies as the Science Academy, Association for the Advancement of Science and mono-disciplinary scientific societies for their considered views.

The Academy in a general meeting of all its fellows held in 1985 carefully considered this draft and gave suggestions on its various aspects. It however, as before, gave utmost stress on the character of what was referred to in the draft as a "centrally institutionalised mechanism". It recommended that this highest national body on science and technology should be named a Commission instead of a committee or council, that is, National Commission on Science and Technology to differentiate it from its mainly advisory role and emphasize its executive function in planning and monitoring the overall R & D activities of the nation.

The body, as suggested, was to be headed by the President of the Republic, with an eminent interest to those developing countries which are still engaged in this exercise.

Obviously, it is not possible here to give even a bare outline of the major components of the Bangladesh S & T policy. But in strengthening and expanding the science infrastructure and attaining greater national capability and self reliance in S & T, much emphasis has been laid on coordinating R & D activities intra and inter-discipline wise in and between research institutions and universities, establishing close liaison between research institutions and productive sectors of the economy and on the development of indigenous technology and adoption and adaptation of foreign technology suited to our conditions. A separate technology policy has not been proposed but for the time being it will remain integrated with the science policy. A high powered Consultative Committee on transfer of technology has already been set up. A decision has already been taken to establish an Engineering Research Council to promote commercialisation of research results and conduct necessary researches in the adoption and adaptation of foreign technology.

We hope that formulation of the S & T policy, preparation of the S & T plan, provision of needed financial resources and effective plan implementation will create necessary conditions for accelerated use of science and technology to achieve national goals.

VISION OF THE FILIPINO FARMER: VISION FOR THE ACADEME

Burton T. Oñate
Alumnus, CA/UPLB

About two years ago, a few concerned agricultural scientists from the academe ventured into the fringes of the countryside to rediscover for themselves the real situation, struggles, hopes, aspirations, and vision of the Filipino Farmer. The real situation as they found out were misery, depression, and poverty. And the fight and the struggle were against the ever presence of "Ang Kumunoy ng Kahirapan" Quagmire of Poverty. Where would the next meal come from?

These learned, wise and educated scientists of the academe had given solutions to the problems of the Filipino Farmer even without visiting the fringes of the countryside, much less see the face of the Farmer. Ironically, after spending millions and millions of pesos on research, instruction, and extension, year in and year out planning for the agricultural sector, and developing models (Galilean/Medical, CLASE/HOLON, or S-I-R), these scientists and technocrats in agriculture are still asking why the small Filipino Farmer is the "poorest of the poor" and the "lowest of the low"? There must be something wrong?

At first, they were afraid to face the truth, for the truth has always been unpopular. The truth is often associated with radicalism or activism. Also, they considered themselves as the cream of the Motherland. As such, they could not make any mistakes. They rediscovered that the billions spent and resources used by the scientists intended to benefit the Filipino Farmer did not at all improve the Farmer's quality of life. The Farmer reported that his quality of life had in fact deteriorated due to his adoption of the "Green Revolution advocated and propagated by these same scientists and technocrats.

Where did the resources go?

Soon, these learned, wise and educated scientists were asking themselves: "Have we been guilty of the highest form of scientific graft and corruption?" "Yes", they said, "we have written comments, books, and papers, contributed to scientific journals, conducted and attended workshops and seminars, travelled extensively abroad and have participated in many other activities that paid us handsomely". But the naked truth and reality is that all these activities were generally irrelevant to the situation, struggles, hopes, aspirations and vision of the Filipino Farmer. These scientists were reluctant to admit that they had not contributed to the improvement of the quality of life of the recipient Farmer from the developmental efforts which should have come from the scientists' research, instruction and extension programs.

These scientists and technocrats realized that they must, perhaps, unlearn, be wiser, and have to re-educate themselves about their past illusions of grandeur in order to be of real service to the cause, aspirations and vision of the Filipino Farmer who they had miserably failed. This is the truth that the scientists and technocrats must face if they wish to develop a Vision.

NGO's Role

While the scientists were in a state of uncertainty on what to do, representatives of Non-Government Organizations who have been living for several months wht the farmers in the barangays informed the scientists how the academe could start to unlearn, and to re-educate themselves on the truth about the politcal, social and economic life of the Farmer. As a first approach, the NGOs suggested that the scientists should learn how to keep quiet and to listen to the Farmer, and then conduct dialogues with him. The scientists soon learned that the Farmer knew the solutions to his problems on a self-reliant basis. The scientists also learned by listening to the Farmer that the philosophy was "people (farmer) oriented solutions to people (farmer) oriented problems", or people before profit. This philosophy also implied a balance between social equity and economic efficiency. Since the philosophy was pro-people, the Farmer was also interested in project and program benefit-monitoring and evaluation system (PPBMES) as the tool in measuring the level, pace and direction of the social impacts of his Vision.

Preserve and Develop our Patrimony: One Dimension of the Vision

The Farmer knows the meaning and implications of preservation, conservation and development of the genetic patrimony of his Motherland without even the benefit of having read the Preamble of the Constitution on Patrimony (". . . preserve and develop our patrimony. . ."). He struggled alone and fought hard to preserve and conserve the rice genetic diversity of his community. Twenty years ago, his countryside boasted of hundreds of rice cultivars the priceless heritage from his forefathers. Now in 1988, all these cultivars (his heritage) are gone and in place one finds one or two foreign developed seeds of the IR variety – from genetic diversity into genetic erosion. The Filipino Farmer wants to recover this genetic patrimony of his Motherland. He is afraid it may be too late. The Filipino Farmer is extra sensitive about his Patrimony. And yet, the scientists refer to the Farmer as unlearned, ignorant and unwise, and less educated and therefore, unlettered. It appears that the scientists do not understand the real meaning of this dimension of the Farmer's Vision.

Dependency, Slavery and Bondage: Another Dimension of Farmer's Vision

The Filipino Farmer wants to be free of dependency, slavery and bondage generated by the use of the IR seeds and its high technology based on costly imported chemicals and poisonous biocides, chemical fertilizers, Transnational Company tractors and high cost external debt based irrigation projects for water control and management. This IR seed and technology had spawned the situation: "Ang Kumunoy ng Kahirapan'. in his rural community. How can the Filipino Farmer be ignorant, unwise and unlettered if he is more sensitive than the academe about freedom, independence, bondage and slavery? Is it because the Filipino Farmer who is "the lowest of the low" is the least brainwashed by decades of Western based propaganda?

Masipag Project

The Farmer then invited the scientists, among others, to be partners with the assistance of the NGOs in the program of preserving the nation's indigenous heritage – genetic diversity in terms of hundreds of rice cultivars and then use this diversity as the springboard to further develop these wider based genetic resources. Bringing back to their barangays, their traditional rice varieties is just the first step, according to the Farmer. He hopes to develop new seeds from his own wider genetic bases which will free him from dependency, slavery and bondage of foreign developed seeds and foreign high cost imported inputs and technology. The Farmer understands that his Vision* is economically feasible, socially acceptable, environmentally sustainable and in accord with the mandates of the Constitution. But the Farmer admitted that to fulfill this Vision, he will need the assistance of the scientists, and the NGOs will serve as the bridge of this partnership. This is the MASIPAG (Magsasaka at Siyentipiko Tungo sa Pagpapaunlad ng Agham sa Agrikultura) partnership.

NEDA Plans: Irrelevant Concepts and Assumptions

The National Economic Development Authority agricultural plans and programs prepared mostly by economists and technocrats from the academe and assisted by foreign institutions, without dialogue with the small poor farmers who constitute the majority of the rural population, emphasized foreign borrowed concepts of pump priming, investments and external debt borrowing, macro measurements of bias against agriculture, purchasing power, inflation rate, Bureau of Trade (Trade) and Balance of Payments (payments) Gross National Product in agriculture and the economy, and the "trickling" down assumption of the GNP growth (5% in 1987) to benefit the lower eschelon of society (top/down approach).

Perhaps, these technocrats in the academe and government, should venture into the fringes of the countryside, listen to the Farmer, dialogue with him, and become real partners in rural development. These technocrats will rediscover the Vision of the Filipino Farmers which the technocrats as partners could adopt as their own. They will realize that there is no such thing as the "trickling" effect in the real world of the Filipino Farmer. These concepts, assumptions and models exist only in the halls and portals of the University and in the minds and writings of the academe and technocrats in and out of the government.

The growth of GNP means very little to the "poorest of the poor" and "lowest of the low". The macro statistics and national growth indicators related to these foreign concepts, assumptions and models adopted by the technocrats are never translated into actual and factual improvement of rural income and more equitable distribution of opportunities, income and wealth as keys to the raising of the quality of life of the underprivileged, the rural poor, as stipulated in Section 1., Article XII (National Economy and Patrimony) of the Constitution.

Invitation to Academe to Share in Farmer's Vision

The Filipino Farmer, like the youth of the land, had become cynical of the academe-prepared NEDA plans and have very little trust on the capabilities of Government Officials to understand the problems and provide solutions to Farmer's problems in agriculture. During the BIGAS Conference attended by more than 40 farmer's organizations from Luzon, Visayas and Mindanao which was held last June, 1985 at the UPLB campus, and after listening to the lengthy and irrelevant dissertations of UPLB academicians, Government Officials and the IRRI Director-General on the status, problems and solutions to the rice industry in the Philippines, one Farmer leader said: "Kayong mga dalubhasa ng Pamantasan ng Los Banos, IRRI at Gobyerno ay masyadong napakataas ng lipad. Kayo po a nasa ulap at hindi alam kung anu-ano ang tunay na nangyayari dito sa kabukiran. Maaari po bang sumama kayo dito sa amin sa sapa, mabasa man lang nang kaunti, upang maranasan ninyo ang tunay na kahirapan, damdamin at adhikain ng maliliit na magsasaka?" Will the academe take the challenge and opportunity of this invitation?

There are many other components of this Vision of the Filipino Farmer. The challenge and the opportunity for the academe and technocrats is to search for the other many dimensions of this Vision. This new acquired Vision from the Filipino Farmer will guide the scientists and technocrats in the academe toward the development and strengthening of new approaches and dimensions to research, instruction and extension which are the functions of the College of Agriculture, University of the Philippines at Los Baños.

The Filipino Farmer wishes the academe good luck in their search for this new Vision. The Farmer is inviting the rest of the academe to join the few concerned agricultural technocrats who have earlier ventured into the countryside. Perhaps, the academe could adopt and develop the Farmer's Vision as their own.

CLOSING REMARKS

Paulo C. Campos
President, National Academy of Science and Technology

Today's session has been quite an eye opener for us regarding science and technology development policies. I am confident that with the experiences of developed and newly developing countries discussed, the Philippines can improve its own policies that would enhance if not ensure success.

On behalf of the Philippine government and the National Academy of Science and Technology thank you very much for sharing with us your wealth of experiences.

LIST OF ICSP PARTICIPANTS

1. Dr. Paz F. Abad
   Polytechnic University of the Philippines
   Sta. Mesa, Manila

2. Dr. Ramon Abarquez
   Philippine National Science Society
   Bicutan, Taguig, Metro Manila

3. Mr. Rhustum Redoble Abdurahim
   Regional Director, RO No. 9
   Pettit Barracks, Western Mindanao
   Zamboanga City

4. Dr. Eustaquia T. Acevedo
   College of Medicine
   Pamantasan ng Lungsod ng Maynila
   Intramuros, Manila

5. Ms. Erlinda R. Aguja
   National Tax Research Center
   4th Floor, BF Condominium
   Aduana, Manila

6. Mr. Naser A. Ajllan
   King Abdulaziz City for Science and Technology
   Riyadh, Saudi Arabia

7. Dr. Rebecca D. Alcantara
   Philippine Normal College
   Taft Avenue, Manila

8. Ms. Bernadette Alejandrino
   Technology Application and Promotion Institute
   TAPI Bldg., DOST Compound
   Bicutan, Taguig, Metro Manila

9. Mr. Suleiman A. Al-Khalifa
   King Adbulaziz City for Science and Technology
   Riyadh, Saudi Arabia

10. Mr. Mubarak S. Al-Odwani
Acting Head, International Relations Section at the Public Relations Information Department Kuwait Institute for Scientific Research
P.O. Box, Safat, Kuwait

11. Dr. Kader H. Al-Shara
Scientific Relations Department
213976 SRC IK

12. Dr. Anna P.E.Amerila
Science Education Institute
Bicutan, Taguig, Metro Manila

13. Dr. Armando A. Andaya
Department of Biology
De La Salle University
Taft Avenue, Manila

14. Ms. Pilar G. Anglo
Industrial Technology and Development Institute
Bicutan, Taguig, Metro Manila

15. Ms. Emerenciana Y. Arcellana
Philippine National Science Society
Bicutan, Taguig, Metro Manila

16. Ms. Violeta P. Arida
Industrial Technology and Development Institute
Bicutan, Taguig, Metro Manila

17. Mr. Antonio A. Avila, Jr.
National Tax Research Center
BF Condominium Bldg.
A. Soriano St., Intramuros, Manila

18. Ms. Aida T. Ayran
Science Education Institute
3rd Floor, PTRI Bldg.
Bicutan, Taguig, Metro Manila

19. Dr. Mustapha M. Babar
Senate of the Philippines
Old Congress, Taft, Ave.
Manila

20. Dr. Marietta C. Baccay
Chief, Medical Division III
Bureau of Research and Laboratories
Department of Health
Sta. Cruz, Manila

21. Dr. Zenaida G. Bagabaldo
Department of Pysiology
College of Medicine
UP, Manila

22. Dr. Clare R. Baltazar
Department of Entomology
College of Agriculture
UPLB, College, Laguna

23. Dr. Feliciano T. Bantilan, Jr.
Institute of Mathematical Sciences and Physics
UPLB, College, Laguna

24. Dr. Carlito R. Barril
Institute of Chemistry
CAS, UPLB, College, Laguna

25. Dr. Emiliana N. Bernardo
Department of Entomology
UPLB, College, Laguna

26. Dr. Solita Camara-Besa
603 Julio Nakpil St.
Malate, Manila

27. Mrs. Leticia S. Bonoan
Deputy Director
PTRI, Bicutan

28. Dr. Nicolas A. Brana, Jr.
Panay State Polytechnic College
Mambusao, Capiz

29. Mr. Tomas Briñas
Technology Application and Promotion Institute
TAPI Bldg., DOST Compound, Bicutan
Taguig, Metro Manila

30. Ms. Gregoria S. Bunales
Industrial Technology Development Institute
Bicutan, Taguig, Metro Manila

31. Dr. Benjamin D. Cabrera
Institute of Public Health
UP, Manila

32. Ms. Leticia J. Cachero
Bureau of Communication Services – OPS
310 San Rafael St.
Philippine Cancer Society Bldg.
Manila

33. Ms. Virginia S. Calix
Philippine Nuclear Research Institute
Don Mariano Marcos Ave.
Quezon City

34. Mr. Sofronio C. Camacho
Forest Development Center
UPLB College of Forestry
College, Laguna

35. Dr. Filomena F. Campos
Ibayo Farms
Dasmarinas, Cavite

36. Dr. Paulo C. Campos
President
National Academy of Science and Technology
Bicutan, Taguig, Metro Manila

37. Dr. Constancio C. Canete
Regional Director – XI
Department of Science and Technology
F. Torres St., Davao City

38. Dr. Magdalena C. Cantoria
10 Malinis St.
UP Village, Quezon City

39. Dr. Edith Carpio
Assistant Director
Bureau of Elementary Education
Department of Education Institute

40. Dr. Gelia T. Castillo
Department of Agicultural Education and Rural Studies
College of Agriculture
UPLB, College, Laguna

41. Mr. Andres F. Celestino
President, University of Eastern Philippines
University Town, Catarman, Northern Samar

42. Dr. Hiralal Chauduri
CAS, IBS
UPLB, College, Laguna

43. Ms. Teresita B. Corpuz
Pamantasan ng Lungsod ng Maynila
Intramuros, Manila

44. Ms. Ruby Cristobal
Science Education Institute
Bicutan, Taguig, Metro Manila

45. Dr. Amante C. Cruz
College of Public Health
UP, Manila

46. Ms. Cynthia Cruz
Philippine Nuclear Research Institute
Don Mariano Marcos Ave.
Diliman, Quezon City

47. Mr. Libertado C. Cruz
Philippine Carabao Research & Development Center
Central Luzon State University
Munoz, Nueva Ecija

48. Dr. Lourdes J. Cruz
Department of Biochemistry and Molecular Biology
College of Medicine
UP, Manila

49. Dr. Conrado S. Dayrit
Vice-President
United Laboratories, Inc.
Mandaluyong, Metro Manila

50. Capt. Cesar de Gracia
c/o Hon. Ernesto T. Estrella
House of Representatives
Room S-205 House of Representatives
National Government Center
Constitution Hills, Quezon City

51. Dr. Ma. Patrocinio E. de Guzman
Deputy Director
Food and Nutrition Research Institute
Taft Ave., Manila

52. Ms. Josefina B. de Jesus
De la Salle University
Taft Ave., Manila

53. Ms. Amelia S. de Juan
College of Pharmacy and Medical Technology
Manila Central University
Sta. Cruz, Manila

54. Dr. Alumanda M. dela Rosa
Philippine Nuclear Research Institute
Don Mariano Marcos Ave.
Diliman, Quezon City

55. Mr. Bengt Delaryd
President
Investor Providentia (Asia) Ltd.
3406 One Exchange Square Central
Hongkong

56. Dr. Rosita R. de Leon
Medical Specialist II
Bureau of Research and Laboratories
Department of Health
Sta. Cruz, Manila

57. Dr. Fe del Mundo
Children's Medical Center
11 Banawe St., Quezon City

58. Ms. Betty del Rosario
PCARRD
Los Banos, Laguna

59. Mr. Marcial Diamante
Science Education Institute
Bicutan, Taguig, Metro Manila

60. Ms. Juanita H. Diaz
Food and Nutrition Research Institute
Taft Ave., Manila

61. Dr. Gloria R. Diokno
Ecosystems Research and Development Bureau
Los Banos, Laguna

62. Mr. Joseph G. Dubouzet
College of Agriculture
UPLB, College, Laguna

63. Ms. Beatrice Duran
Regional Office No. 8
Department of Science and Technology
Nipa House, Lopez Jaena St.
Tacloban City

64. Dr. Salcedo L. Eduardo
College of Veterinary Medicine
UPLB, College, Laguna

65. Dr. Manuel R. Eugenio
Executive Director
Science Education Institute
Bicutan, Taguig, Metro Manila

66. Mr. Alejandro C. Flores
National Tax Research Center
First BF Condominium
Aduana, Intramuros, Manila

67. Dr. Miguel D. Fortes
Marine Science Institute
College of Science
UP, Diliman, Quezon City

68. Mr. Romeo D. Fortes
Director
Aquaculture and Inland Fisheries Division
PCAMRD

69. Dr. Ruben M. Gapasin
Visayas State College of Agriculture
Baybay, Leyte

70. Dr. Edito Garcia
College of Public Health
UP, Manila

71. Dr. Lourdes Garcia
Pamantasan ng Lungsod ng Maynila
Intramuros, Manila

72. Ms. Margarita D. Generoso
Industrial Technology Development Institute
Bicutan, Taguig, Metro Manila

73. Dr. Ann Inez N. Gironella
IMSP, CAS
UPLB, College, Laguna

74. Ms. Antonia L. Gonzales
ITDI, DOST Compound
Bicutan, Taguig, Metro Manila

75. Mrs. Luzviminda Guerrero
Aquatic Biosystems
Bay, Laguna

76. Dr. Rafael D. Guerrero III
Aquatic Biosystems
Bay, Laguna

77. Mr. Honorio Gumangan
Ifugao State College of Agriculture and Forestry
Nayon Lamut, Province of Ifugao

78. Prof. Ibrahim Haddad
Director-General, Atomic Energy Commission
Syria, Damascus
P.O. Box 6091

79. Prof. Horst Hagedorn
Member, DFG Senate
Institute fur Geographi de Universitat Wurgburg

80. Dr. Ponciano M. Halos
Monsanto Philippines, Inc.
136 Amorsolo St., Legaspi Village
Makati, Metro Manila

81. Dr. Carmen Ll. Intengan
1736 Banyan Road
Dasmarinas Village
Makati, Metro Manila

82. Dr. Rosario D. Jose
De La Salle University
2401 Taft Ave., Metro Manila

83. Mr. Alejandro Judan, Jr.
Liberty Flour Mills

84. Dr. Bienvenido O. Juliano
Department of Cereal Chemistry
IRRI
College, Laguna

85. Dr. F.S.C.P. Kalpage
President, Sri Lanka Association for the Advancement of Science
Vidya Mandiraya 120-10
Wijerama, Mawatha
Colombo 7, Sri Lanka

86. Dr. Quintin L. Kintanar
Assistant Secretary
Department of Health
Sta. Cruz, Manila

87. Dr. Alfredo V. Lagmay
Department of Psychology
College of Social Sciences and Philosophy
UP, Diliman

88. Ms. Luningning M. Lansangan
Philippine Nuclear Research Institute
Don Mariano Marcos Ave.
Diliman, Quezon City

89. Ms. Erlinda A. Legaspi
Industrial Technology Development Institute
Bicutan, Taguig, Metro Manila

90. Ms. Gloria T. Leonardo
Bureau of Communication Services
Office of the Press Secretary
310 San Rafael St., San Miguel
Metro Manila

91. Mr. Florentino Librero
UPLB, College, Laguna

92. Dr. Clara Y. Lim-Sylianco
Department of Chemistry
College of Science
UP, Diliman, Quezon City

93. Prof. Erh K. Lon
Institute of Physics
Academia Sinica
Taipei, Taiwan 119, ROC

94. Dr. Ernesto S. Luis
Chief, National Standards & Testing Laboratory
Industrial Technology Development Institute
Bicutan, Taguig, Metro Manila

95. Ms. Alicia Lingao
Chief, R & D Management Division
PCHRD
Bicutan, Taguig, Metro Manila

96. **Prof. Rosalinda M. Mabalot**
Technological University of the Philippines
Dasmarinas, Cavite

97. Mr. Michael Macalanggan
Office of Senator Tamano
4th Floor, Phil. Veterans Bank Bldg.
Bonifacio Drive, Manila

98. Mr. Froilan T. Maglaya
Technological University of the Philippines
Taguig, Metro Manila

99. Dr. Melecio S. Magno
Vice-President
National Academy of Science and Technology
Bicutan, Taguig, Metro Manila

100. Dr. Marwan Mahmoud
Solar Energy Research Center
Royal Scientific Society
P.O. Box 925819
Arman, Jordan

101. Dr. Eugenia C. Manoto
Philippine Nuclear Research Institute
Don Mariano Marcos Ave.
Diliman, Quezon City

102. Dr. Felix Maramba, Sr.
Liberty Flour Mills

103. Ms. Thielae R. Marcayda
Office of Sen. Rene A.V. Saguisag
9th Floor, PVB Bldg., Bonifacio Drive
Port Area, Manila

104. Mrs. Floredeliza S. Melendez
Department of Science and Technology
Bicutan, Taguig, Metro Manila

105. Mr. Manolo G. Mena
College of Engineering
UP, Diliman, Quezon City

106. Dr. Evelyn Mae T. Mendoza
Institute of Plant Breeding
UPLB, College, Laguna

107. Mrs. Cindy Montelibano
Ninoy Aquino International Authority
Ninoy Aquino International Airport, Pasay City

108. Mr. Antonio Morales
Bureau of Communication Services
Office of the Press Secretary
310 San Rafael St., San Miguel, Manila

109. Mr. Ibrahim R.A. Muneef
King Abdulaziz City for Science and Technology
Riyadh, Saudi Arabia

110. Dr. Quirino O. Navarro
Director
Philippine Nuclear Research Institute
Don Mariano Marcos Ave.
Diliman, Quezon City

111. Fr. Bienvenido F. Nebres, S.J.
Department of Mathematics
Ateneo de Manila University
Loyola Heights, Quezon City

112. Ms. Milagros R. Ninonuevo
Rizal College of Agriculture & Technology
Sampaloc, Tanay, Rizal

113. Mr. Enrico Obias
Liberty Flour Mills

114. Ma. Rosario D. Ocampo
Food and Nutrition Research Institute
Taft Ave., Manila

115. Ms. Ester B. Ogena
Deputy Director
Science Education Institute
DOST, Bicutan, Taguig, Metro Manila

116. Dr. Luz Oliveros-Belardo
Philippine Women's University
Taft Ave., Manila

117 Ms. Luzviminda Ong
Faculty
College of Pharmacy
Manila Central University

118. Ms. Merlita Opena
Chief, Communication & Information Division
PCHRD, DOST, Taguig, Metro Manila

119. Dr. Faustino T. Orillo
Department of Plant Pathology
College of Agriculture
UPLB, College, Laguna

120. Mr. Juanito L. Patalinghug
Office of Senator Tamano
4th Floor, PVB Bldg.
Bonifacio Drive, Manila

121. Ms. Wyona C. Patalinghug
De La Salle University
2401 Taft Ave., Manila

122. Ms. Daisy Pavon
Eulogio "Amang" Rodriguez Institute of Science and Technology
Nagtahan, Sampaloc, Manila

123. Mr. Olimpio Pena
Philippine Institute of Volcanology and Seismology
Hizon Bldg.
29 Quezon Ave., Quezon City

124. Ms. Teresita C. Perez
National Tax Research Center

125. Ms. Sawwaluck Phumiwasana
Research Policy and Planning Division
Office of National Research Council of Thailand
Bangkok, 10900
Thailand

126. Ms. Natividad O. Platon
Industrial Technology Development Institute
Bicutan, Taguig, Metro Manila

127. Engr. Joselito Picar
Department Chairman
Civil Engineering
Pamantasan ng Lungsod ng Maynila

128 Dr. Dolores A. Ramirez
Dean
Graduate School
UPLB, College, Laguna

129. Mr. Romeo S. Recide
IMSP, UPLB
College, Laguna

130. Dr. Arsenio N. Resurreccion
College of Engineering & Applied Technology
UPLB, College, Laguna

131. Ms. Maria Angeli T. Reyes
De La Salle University
Taft Ave., Manila

132. Ms. Ramonessa R. Ricardo
Chemistry Department
De La Salle University
Taft Ave., Manila

133. Dr. Eugenio S. Sabalvoro
DOST, RO No. 6
La Paz, Iloilo City

134. Ms. Gloria Salandanan
Regional Science Teaching Center
Philippine Normal College
Taft Ave., Manila

135. Prof. Marcelo Salazar
MSU-Iligan Institute of Technology
Iligan City

136. Mr. Joseph Samonte
Institute of Plant Breeding
UPLB, College, Laguna

135. Dr. Alfredo C. Santos
1276 Syson St.
Paco, Manila

138. Prof. Dr. Didin S. Sastrapradja
Vice-Chairman
Indonesian Institute of Sciences
Jl. Jend. Gatot Subroto
P.O. Box 250
Jakarta, Indonesia

139. Dr. Fortunato Sevilla III
Research Center for the Natural Sciences
UST, Espana, Manila

140. Mr. Jerome F. Sison
Center for Policy and Development Studies
UPLB, College, Laguna

141. Dr. Flora G. Siwa
The Medical Center Manila
University Physicians Services, Inc. (UPSI)

142. Prof. Miriam M. L. So
Senior Lecturer
Biology Department
Hongkong Baptist College
224 Waterloo Road
Hongkong

143. Dr. Joventino Soriano
Department of Botany
College of Science
UP, Diliman, Quezon City

144. Dr. Dioscoro L. Umali
Batong Malake
College, Laguna

145. Dr. Jose R. Velasco
Imus, Cavite

146. Dr. Carmen C. Velasquez
P-11 Area 14
Roces Ave., UP Diliman

147. Dr. Gregorio T. Velasquez
P-11 Area 14
Roces Ave., Quezon City

148. Dr. Benito S. Vergara
IRRI
College, Laguna

149. Dr. Prescillano M. Zamora
Director
Institute of Biology
UP, Diliman