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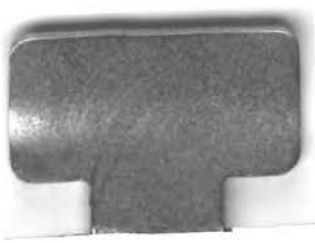

PHILIPPINES - U.S. WORKSHOP

ON

INDUSTRIAL RESEARCH

PART II

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CONTENTS

PART II WORKING PAPERS

INDUSTRIAL RESEARCH AND ECONOMIC DEVELOPMENT

By David SyCip

A. INDUSTRIAL RESEARCH

Definitions

Industrial research is technological research or research in applied science. It is research intended to improve the totality of means employed to produce objects necessary for human sustenance and comfort.

It can be divided into two classifications: fundamental research and applied research. Fundamental research has two products. The first is new knowledge, and the second is new scientists. Applied research is research directed towards development of new or improved processes or products for primary or secondary industry.

Role in Developing Countries

The problem of developing countries is to accelerate the rate of economic development, which is indicated by accelerated increase in real per capita income.

The sources of long continuous rise in per capita real income are directly traceable to a long continuous rise in the productivity of labor, which means reduction in cost of production. Technological change both reduce the cost of producing existing goods and create new or improved products for consumption or further production. One can say, however, that such new or improved products are merely better or less expensive ways to produce already existing services. Industrial research accelerates this technological change. To have any real chance in economic development, a developing country must give highest priority to research. Priority should, however, be given to applied research rather than to fundamental research: a frank recognition of resource limitations.

Prospects for Applied Science and Technology

Developing countries have the advantage that the accumulated scientific and technical knowledge of the developed countries is generally available to them. They should utilize all the available knowledge, but work out the techniques specifically suitable to their actual conditions. Developing countries should recognize that in developed countries labor is the relatively expensive (and sometimes scarce) factor, rather than land or capital. Hence, new production techniques in the developed countries often mainly tend to save labor. But in the developing countries it is capital-saving innovations that are needed, simply because it is the relatively scarce and costly factor.

Apart from adapting and applying superior techniques already in use elsewhere, research should be directed towards genuine capital-saving innovations to meet the special problems of the developing countries. For example, innovations to lower the minimum economic manufacturing volume levels thru the reduction in fixed manufacturing overhead costs.

There is, however, another school of thought whose argument is that capital-intensive methods may be preferable despite the scarcity of capital relative to the other factors. It believes that capital-intensive methods produce a distribution of income favorable to profits and, in turn, to capital accumulation. This is mentioned to point out that this is a problem that does not lend itself to a black and white solution. The size of the market and the competition faced are some of the factors that bear on the problem.

B. PHILIPPINES'S ECONOMIC GROWTH POTENTIAL AND NATURAL RESOURECS

Economic Growth Potential

When one speaks of the growth potential of the Philippines, one needs to be reminded that the economic decisions which determine the rate of growth are not governed by the strictly economic motives of human beings. Economic action results from a balancing of material and non-material human objectives. It is the reflection of value judgments which both influence and are influenced by the social and political structure. One can safely say that the potential for Philippine economic growth is assured by the emergence of the Filipino entrepreneur, with socially-conditioned initiative, ambition, and spirit of adventure. He is, however, typically Filipino in his propensity to seek advantage through political institutions and processes. Although traditionally "business oriented" rather than "industry oriented", he is emancipating himself from the "trader's mentality", which signifies an alleged unwillingness of merchants to tie up their capital in long-term and fixed investments, or to have a great number of employees. The value structure reflects an increasing aspiration for the good things of life — the will to develop. The available natural resources complement this urge for growth and promise a brighter future for our country, but the problems of development are considerable and there is undoubtedly an urgent need for the government to give a firmer sense of direction to the economic activities of the people. In the context of a clearly defined *national* purpose: too much of our scarce resources are wasted in uneconomic activities.

Natural Resources

(a) *Forest.* Forty-one per cent of the total land area of the Philippines is covered with forest, and of this two-thirds is classified as commercial forest. There is immense variety in the forest products of the Philippines, ranging from a wide array of timbers in demand by local and overseas consumers, to plants used for paints, varnishes and dyes and those such as the

orchids which have a market because of their beauty.

(b) *Metallic minerals.* The search for minerals has not been extensive but those known to occur in quantity are gold, silver, iron, lead, copper, manganese, nickle and chrome, with some mercury.

(c) *Non-metallic minerals.* These are coal, limestone, sulfur, silica, asbestos, salt and construction materials (stones, etc.). There is also a good deal of marble and some rock asphalt. More extensive prospecting should uncover more mineral resources.

(d) *Fish.* There are ten principal fish contributing to the wealth of the economy. Sardines, tuna, herring, anchovies, shrimps are amongst those exploited, but the scope of development is believed to be immense. Some authorities, however, claim that there is not the concentration of schools of fishes essential to support canneries.

(e) *Water power resources including hydro-electric power.* The total hydroelectric power potential is estimated at a minimum of 2.4 million KW. Irrigation potential integrated with power production or alone is very considerable.

The above list the principal known natural resources but much needs yet to be done in the matter of exploration and development of prospects.

C. PHILIPPINES' INDUSTRIAL GROWTH

A Historical Appraisal

Prior to World War II the country had an essentially agricultural-commercial economy. Exports, except for gold and a few other minerals, were almost exclusively agricultural products — and imports supplied almost all the manufactured goods used by the people.

In the 1950s, under the stimulus of import controls, a host of import-substituting industries were developed. Although many of the industries established were relatively superficial, quite a few have achieved a meaningful degree of backward integration.

From assembling or blending imported components many industries have moved to manufacturing some or most of the components, although quite often under foreign licenses. In an increasing number of industries products are being manufactured under domestic brand names with the use of only general imported technological know-how, and in a few industries specific domestic technological know-how has been applied to the manufacture of products with features specially designed for local conditions.

Although an organized and coherent sense of direction was often lacking (the administration of the import controls, the Basic Industries Law, etc. all reflected the lack of such a sense of direction), the government appears to be developing such a sense of direction now. The recently passed Investment Incentives Act promises to give more organized and more coherent direction to the country's industrial development. The government has an important role in spurring industrial development in a developing country, and the Philippine government is beginning to play this role more meaningfully now.

Problems

The problems facing the Philippines in its efforts to develop more rapidly are many.

To mention a few: out-dated tariff and tax codes designed for a basically commercial economy; the lack — and the hight cost — of capital, and the consequent unwillingness — as well as inability — to invest for the longer pull required for meaningful industrialization; the lack — generally — of a large enough home market to support sufficiently economic manufacture of many products; the lack of blue collar skills (which may be even harder to fill than the need for higher level technical skills); inadequate foreign exchange earnings to support the import of capital goods, raw materials and finished consumer goods not yet produced in adequate quality or quantity locally; the disproportionate influence of government spending on the rest of the economy; etc.

These are formidable problems, and the government will need to plan intelligently and act firmly if the problems are to be surmounted.

D. PHILIPPINES' INDUSTRIAL RESEARCH

The National Science Development Board's report on "Science and Technological Research and Development Program for FY 1968-1969 to FY 1971-1972" states: "The effectivity of Philippine science as a tool for national progress has been limited. This has been due to several factors. First, available funds are still inadequate for the scientific work at hand, let alone for expansion. Second, the lack of current information on the state of our natural resources and scientific potential has limited planning for their development and utilization. Third, the country's stock of highly trained scientists and engineers, although already inadequate for a vigorous national research program, is being depleted by emigration to other countries. Fourth, there is the lag in the circulation and application of scientific knowledge emanating from traditional practices in the communications field. Fifth, current research facilities and physical plants have not been expanded and modernized due to the shortage of financial support."

From the private sector's point of view, the general lack of industrial research is probably not critical at the present stage of industrial development. Almost all of the basic — and much of the applied — technology can be borrowed or purchased from abroad. But efforts to export manufactured goods are not likely to succeed significantly unless the Philippines is capable of undertaking a larger measure of applied research at least. The problem, of course, is that even applied or adaptive research can cost considerable sums of money and may require a larger manufacturing base than many industries are able to achieve in the relatively small Philippine market.

In an appraisal of the need to invest in research, Dr. Frank CoTui stated:

> "Local private capital is still timid, obsessed with a colonial mentality, consciously or subconsciously being skeptical of native talent.

But the private sector must realize that no science in a democratic country can exist until investors invest in the products of their country's scientific research.

"And our general scientific effort, by and large still at the test tube stage, would be stunting the growth of our scientific potential, which ultimately would affect the private sector adversely.

"The private sector cannot afford to continue the importation of technological processes from abroad and adopt them in toto for local use. Almost invariably adaptive research has to be done, and this can be best performed in the existing government agencies mentioned earlier.

"The establishment of these agencies implies a commitment on the part of the government, however vague and ill-defined, to provide a servicing, path-finding and pioneering apparatus in science and technology for the ultimate benefit of the private sector which in essence is the nation. The government should now take the next step in establishing an apparatus that would pick up the economically promising researches still in the test tube stage, carry them through the necessary pilot stage, and sell the perfected process to the private sector for exploitation at a price which would encourage further research effort."

The cliche about underdeveloped countries is that their people are "carriers of water". Progress for such peoples should not stop at using pumps to carry the water, or even assembling – or manufacturing – the pumps they use under foreign licenses. Progress should bring pumps designed and manufactured by themselves. And to achieve this they must be able to undertake their own industrial research.

AN IMPERATIVE OF ECONOMIC PROGRESS: INDUSTRIAL RESEARCH(*)

By
JUAN SALCEDO, JR.
Chairman, National Science Development Board

I

In forums here and abroad, the importance of research and development in improving living standards seemed to have been commonly accepted. Research, it is said, leads to technological change; and a number of economists have stressed that technological change has indeed contributed to between 50 and 90 per cent of advance in productivity. Of course, we are all aware that technological change is but one factor in increasing productivity. Changes in the quality of the "traditional" inputs of management, labor and organization have played undoubtedly a major role. But when one compares the goods sold on the market and the techniques utilized to produce them today with the goods and techniques of the past, the contribution of research and development is indeed dramatized.

And yet, in the international reports produced by the United Nations, a wide divergence is found in comparing the experience of the industrialized nations and the modernizing nations. For instance, the increase in per capita income of the industrialized nations in the early 1960's averaged a hundred dollars, while the increase in the modernizing nations was five dollars; (E/4071). And the growth rates in the national incomes of the modernizing nations have decreased, from 4.5 per cent between 1955 and 1960, to 4 per cent in recent years. (E/4059) These may be crude indicators of living standards, but other studies have tended to support this trend. The ILO reports in 1965 that in the modernizing nations, the levels of unemployment remained high, with employment possibilities failing to absorb excess manpower. The FAO, in its review of the state of food and agriculture in second post-war decade, reports that the production of food per capita in the less fortunate nations increased by only one per cent, while that of the industrialized nations increased by fourteen per cent.

The explanations given for this imbalance lay stress on many factors with which the modernizing nations have to contend with: the uncertainty and instability of export incomes, the difficulty of access to developed markets, the structural bias of the world economy towards the interests of the industrialized nations, and the lessening dependence upon primary products.

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Internal instabilities have also been stressed: the lack of political will, difficulties in arriving at a consensus on goals and strategies, the lack of highly trained manpower and disparities in the distribution of income. And there is the seeming failure by the less fortunate nations to apply research and development to their efforts to modernize their economies and activities.

II

It has been pointed out by one of the scholars who pioneered in studying science and economic development, that less than one-fifth of the countries of the world, possessing about one third of its population, spend more than 95 per cent of the world's research and development funds, and utilize practically *all* of the research outputs of the world today. (Dedijer, 1963, p. 63). In recognition of this situation, UNESCO and ECAFE sponsored a conference of Asian nations at New Delhi in August last year to assess the efforts made by Asia in the application of science and technology to development.

This Conference on the Application of Science and Technology to the Development of Asia gave us an opportunity not only to assess our country's own efforts but also to compare our experience with that of the other Asian nations. Based on the percentage of GNP being expended on research and development, the following is a ranking of several Asian countries:

Japan	1.20%
Thailand	1.04%
Iran	0.45%
Republic of China	0.39%
Ceylon	0.35%
India	0.34%
Republic of Korea	0.28%
Pakistan	0.27%
Philippines	0.22%
Nepal	0.14%
Singapore	0.05%
Cambodia	0.01%

Although the Philippines placed only ninth in this ranking, there were other considerations that pointed out some reservations in the reliability of this ranking system. To mention some: the fact that our country met with substantial success in the application of science and technology to the production of rice, our ability to implement a widespread infrastructure program, the percentage of our school population pursuing degrees in higher education (which is second only to the USA), and our efforts to provide facilities for science education (especially textbooks) to the greatest number of first level school children.

The most difficult problem was to evaluate the national efforts made to apply reesarch to the country's economic development. The National Science

Development Board has been engaged, in the past decade, in the *collection of information on expenditures on research and development activities of the country.* Because of the *lack of reliable yardsticks* on the relations between research and its application, the Board *has not been able to conduct definitive studies* in this regard and the data available describe only the financial inputs.

As we pointed out earlier, the Philippines spends about 0.045 of total government budget in 1970 0.22% of its GNP on research and development activities. This falls below the UNESCO minimum objective of 0.5%, which was adjudged as a reasonable estimate for investments in science for the low-income countries. Of this 0.22 percent, *over half* was expended by the *Philippine Government.* The following shows the proportion of government funds to total funds for research and development in selected countries, as reported by the Organization for Economic Co-operation and Development in 1965:

USA	63.8%
France	63.3%
U.K.	56.6%
Philippines	*54.0%*
Sweden	47.7%
Germany	40.4%
Netherland	40.0%
Japan	27.8%

With the Philippine Government spending 54.0% of the total research and development expenditures, one of the oft repeated statements of policy by government officials is the desirability of further decreasing this share, and of inducing private industry to participate more actively. In fact, this was one of the basic goals of President Carlos P. Garcia when he proposed to Congress in 1958 the organization of the National Science Development Board. Accordingly, the NSDB attempted to implement this mandate by providing incentives to private industry through offers to finance research undertakings and exempting from taxes the equipment or donations for research.

But research by private industry is expensive, and development much more expensive – especially when we consider the chronic low level of capital available to the private sectors, even for establishing industrial projects. One could very well ask the question: "Should the government continue to provide the funds for research, until private industry has built up its capacity to contribute substantially to research?" (And, I may cite here the experience in the USA. In 1953, the US Government provided 52.8%, and industry, 43.0% of total research funds. In 1965, the US government's share rose to 68.9%, while that of industry dropped to 31.9%). OECD, 1968, p. 148)

But to return to the Philippine Government, its scientific activities were developed not as part of a master plan, but rather as a response to the needs of the specific program responsibilities of the various governmental departments and agencies. The general policy was to allow science to develop in relation to the specific missions of each governmental organization: health, agriculture, defense, etc. From FY 1959 to FY 1966, government expenditures in science

and technology rose from ₱9.6 million to ₱21.4 million, an increase of almost 227 per cent.

In studying how the government spent its funds, what is evident is a slight shift from basic and fundamental research to applied research and development activities. In 1959, the government spent 16.8 per cent on basic research and 83.2 per cent on applied research; in 1966, it was 14.0 per cent for basic research and 86.0 per cent for applied research. Taking a narrow definition of industrial research, the proportion of money spent on industrial research to total research funds dropped from *9.1 per cent in 1959* to *5.9 per cent in 1966.* This we can consider as the result of an emphasis on researches on food production — which I believe has shown some success. The proportion spent on agriculture research increased from 45.4 per cent in 1959 to 50.2 per cent in 1966.

And the main bulk of governmental research (about two-fifths) is undertaken by the Department of Agriculture and Natural Resources. The following table shows the share of government agencies to the total governmental research expenditures in FY 1966

Dept. of Agriculture and Natural Resources	40.7%
National Science Development Board and its agencies	13.6%
Office of the President [a]/	13.3%
Dept. of Commerce and Industry	10.6%
Dept of Education	3.0%
Dept. of Health	2.7%
Dept. of National Defense	1.7%
Dept. of Public Works & Communications	0.8%
Dept. of Labor	0.8%
Other Offices [b]/	12.8%

a/ Abaca Development Board, Agricultural Productivity Commission, Board of Technical Surveys and Maps, Agricultural Tenancy Commission, National Coordinating Center for the SDFCY, Philippine Virginia Tobacco Administration, PACD, Presidential Economic Staff, SSS and Tariff Commission

b/ NRCP, Commission of Volcanology, BTTI, Central Bank, Joint Legislative-Executive Tax Commission and PNB

To insure that expenditures on research and development by the government are undertaken in relation to national priorities, the National Science Development Board was organized ten years ago. With the funds given the Board averaging only about 13.6 per cent of the total government outlays in research, it can readily be seen that its programs could not have had the desired impact on the entire governmental system. However, the

NSDB chose to be selective in its support for research projects. In other words, the Board tried to fill the gaps in the research efforts of the government. Projects of priority which could not be undertaken by other government agencies due to lack of funds were given financial aid by the NSDB. With this as a guiding principle, it is not surprising that the field of agricultural research received a great share of NSDB funds—for the reason that food production had a high priority in our national development plans, and that the agricultural agencies of the government had the research people and the capacity to undertake research.

However, there have been two recent changes in the orientation of our policy-makers towards research in general, which I believe will bring about not an effective coordination of governmental as well as private, research efforts, but also accelerate the application of science and technology to development, and build up the research capabilities of other research institutions.

The *first* is a recognition of the shortsightedness of traditional economic theories on economic growth which considered science and technology as mere residual factors. Our present decision-makers in the government, both in the executive and legislative branches, have explicitly recognized research as an important factor of production, which although it may not have immediate visible effects will eventually redound to our economic and social progress. This is indeed a courageous stand, especially when we consider the demands made for immediate results which have in the past obfuscated long range planning.

The *second* change in orientation, which is the result of the first, is the allocation of greater share of funds to scientific research and development. You are all aware of the passage of the Special Science Fund. The collection from the science taxes doubles the money available for all government research. The responsibility for the effective and efficient utilization of this Fund falls on the National Science Development Board and the National Research Council of the Philippines. However, in the planning of its use, we recognize that no one agency has the monopoly of expertise. Rather, we have to depend largely on the opinions, not only of scientists, but of economic planners, business leaders, and educators. Or to paraphrase a popular saying: "science is too important to be left alone to the scientists."

With these two recent developments, I believe that a report on the "Current Research Efforts Within the NSDB Complex" would be inadequate for the reason that we in the NSDB intend to change the directions of our efforts in the past ten years. Rather than dwell exclusively on the past research efforts, allow me to present to you the organizational capabilities of the NSDB and its Agencies. As the economists are so fond of speaking about "policy instrument," may I also be permitted to talk about the NSDB Complex as an "instrument" for the application of science and technology to development, that is, for "industrial research."

But I would like briefly to make clear what we mean by "industrial research" in general. To plan for national development, it is necessary to

recognize the close interdependence of industrial development and agricultural development. Industrial research plays a major role in maintaining this interdependence and in progressively shifting the base of an economy from agriculture and handicrafts to manufacturing industries. It is in this sense in which we shall consider industrial research.

III

The National Science Development Board (NSDB) is the highest science policy making body in the Philippines entrusted with the legislative mandate "to integrate, coordinate and intensify scientific and technological research and development." It has under its supervision five (5) agencies: the National Institute of Science and Technology (NIST), the Philippine Atomic Energy Commission (PAEC), the Philippine Coconut Research Institute (PHILCORIN), the Philippine Textile Research Institute (PTRI), and the Philippine Inventors Commission (PIC). The NSDB Chairman is also the Chairman of the National Water and Air Pollution Control Commission, the Board of Directors of the Metals Industry Development Center, and the Board of Trustees of the Philippine Science High School.

Aside from a Chairman, the NSDB has a Vice-Chairman who is concurrently the Executive Director. Both of them are ex-officio members of an eleven-member Governing Board composed of the following: the Commissioners of the NIST and the PAEC; the Chairman of the National Research Council of the Philippines; the Director of the Office of National Planning of the National Economic Council; a representative from the University of the Philippines who is designated by the President of the University; and members representing industry, agriculture, education and scientific and/or technological associations or societies who are appointed by the President of the Philippines with the consent of the Commission on Appointments upon recommendation of their respective professional groups and whose terms of office are for a period of three (3) years.

In the ten years of its existence, the National Science Development Board has chosen to utilize the "financial grant" as the most flexible means to carry out effectively its mandate. The Board had accordingly, directed its activities to providing financial support for research and development towards the attainment of socio-economic goals, and to providing funds in support of science education to insure a supply of adequate scientific and technological manpower for our country's needs.

In the implementation of its research and development program, the NSDB encourages and/or invites project proposals from the local scientific community. As a general procedure, these proposals are evaluated as to scientific merit not only by the technical staff of the NSDB but by outstanding scientists whose opinions and comments are sought. The Board has also technical consultants assigned to the various fields of research to assist in this work.

The project proposals submitted for financial and/or technical assistance are reviewed for their merit and soundness, flexibility, possible impact on the national economy and their rating in the established scale of priorities. The system of priorities formulated by the Board takes into consideration the benefits to be derived from the research, its urgency, and its technical nature. In cases where few project proposals are submitted for particular studies deemed necessary, the Board initiates the development of research projects to be undertaken by public and private enterprises.

A study of the ₱20 million grants-in-aid made by the NSDB in the past ten years shows that government agencies received about 56 per cent of the grants, and educational institutions, about 40 per cent. Grants for studies geared towards the development of the country's industry amounted to ₱10.2 million. A percentage breakdown of this amount gives the following proportions: agriculture and natural resources, 36.4%; industry and engineering 37.2%; food, nutrition and biochemistry, 9.9%; others, 6.5%.

Research on agriculture and natural resources were aimed at improving the quality and the quantity of our agricultural production in order to meet ever-increasing requirements for direct consumption and raw materials for industry. Research studies in industry and engineering were geared towards surmounting present obstacles to the national effort of accelerating industrial growth through exploitation and utilization of local resources. Researches in the fields of food, nutrition and biochemistry were directed towards improving health through proper nutrition through studies on food research, experimental nutrition, nutrient requirements, clinical nutrition, evaluation of nutrition studies and institutional management.

Among the significant industrial research activities the NSDB were:

- The discovery of net and twine preservatives which could increase the efficiency and durability of fishing nets and modernize the fishing gear preservation techniques of Filipino fishermen;
- Studies on Philippine seaweeds and algae which are potential sources of cheap protein concentrates as substitutes for fish meal in the preparation of animal feeds;
- The construction of a low-cost equipment for pulping for the pulp and paper industry;
- Studies of the Malangas field which contains coal deposits with good cooking variety for the steel, iron, and other heavy industry using metallurgical coal;
- Studies on animal by-products to improve local supply of rawhides and skins, modernize tanning techniques, utilize fallen animals and produce tanning materials on the cottage industry level;
- The construction and installation of a foundry research laboratory of the Philippines to assist local foundries in the solution of problems on raw material selection, analysis and operational procedures;

- The estimation of rainfall amounts by radar to improve weather forecasting (data collected are used in assessing water resources such as rainfall for water supply, power development, irrigation and in the preparation of meteorological forecasts and flood forecasting schemes);
- The formulation of a textile research program which involved rendering assistance to the textile industry such as the upgrading of local textile standards, dissemination of information on local textiles, physical and chemical tests on fibers, yarns, textile fabrics, dyestuffs and others;
- The study of the Tiwi geothermal area in Albay as a source of power for rural and urban electrification, and chemicals and fertilizers for agriculture;
- Studies of the chemical composition of the coconut leaf by chemical and physical analysis and various methods of pulping and determine the economic feasibility of the end products;
- A project aimed to develop quality standards for Philippine manufactured products sold locally and exported to serve the best interest of the buying public;
- Studies to determine the possibility of reducing imported raw material requirements on fibers or cloth by finding new uses for our native fibers;
- The organization and maintenance of a working group of the Metals Industry Development Center; and
- Studies on agricultural raw materials as sources of chemical products and derivatives for use in local industries such as textile, paper, pharmaceutical, paint and plastics.

IV

THE NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY — — is one of the oldest research establishments in the country. Its history started in 1901 at the organization of the Bureau of Government Laboratories. Since then, it has undergone several changes of names and functions, all of which reflected the changes in the demands of society on the governmental scientific system. In 1905, it became the Bureau of Science, and in ten years it was able to establish itself as one of the leading research centers in Southeast Asia because of the high level of distinction of its work. In subsequent years, its personnel and functions were farmed out among the other government agencies to staff and constitute their own research units.

At the end of the Second World War, it was re-named the Institute of Science in 1946 the Institute of Science and Technology in 1950, and the National Scientific and Industrial Research Institute in 1956. With the passage of the Science Act of 1958, it became the National Institute of Science and Technology under the supervision of the NSDB.

Its present organization emphasizes research activities and technical services, both of which are geared to priorities and requirements of our country: Its research activities are undertaken by the following research centers: *Industrial Research Center, Biological Research Center, Food and Nutrition Research Center, Medical Research Center, Agricultural Research Center,* and *Scientific Instrumentation Center.*

The Industrial Research Center has as its guiding policy the testing of industrial processes on the pilot scale, and the design and fabrication of equipment and tools for the factory and farm. A large part of its activities is concerned with coconut technology, ceramics and chemicals from copper ore. A scheme of processing coconut meat into a highly quality dessicated coconut products was tested in semi-commercial scale, in cooperation with Peter Paul Coconut Corporation. Surveys of clay and feldspar deposits were made, and researchers were completed which make it possible to manufacture electrical insulators, laboratory wares and household fixtures from ceramics. We plan to continue these activities until techno-economic studies would indicate that they are ready for commercialization. We also plan to conduct research on fuels and metals, explore other ores as sources of agricultural and industrial chemicals, and intensify studies in food preservation and processing.

The *Biological Research Center* as a matter of policy concentrates on microbiology, especially micro-organisms with possible industrial application. This choice was made to avoid duplication and overlapping with other biological researches being undertaken by the Bureaus of Plant Industry and Animal Industry, the Philippine Fisheries Commission and the University of the Philippines. Accordingly, its researches are conducted with the view to explore and discover micro-organisms of unique properties, to explore their industrial uses and to study the best culturing conditions. We plan to intensify its studies on protein production, increase attention to marine and brackish water organisms, and develop commercial feasible processes.

To undertake research on food and nutrition and to promote nutrition-consciousness—these are the main aims of the *Food and Nutrition Research Center.* This Center has undertaken extensive nutrition surveys, established nutritional requirements of Filipinos, conducted studies on nutritive contents of foods and the presentation and processing of food, and coordinated national nutrition programs. Its food researches produced: a breakfast cereal, fortified with coconut flour, which was richer in protein content and also produced from local materials, and "instant patis" and "instant toyo" more delicious than imported breakfast foods. Canned infant foods were processes were also developed. These activities will be continued; and in the field of food science, emphasis will be given to the development of new food products from local sources.

The *Medical Research Center's* activities center on pharmaceutical and biochemical researches. It has conducted researches on antibiotics, anti-cancer agents, and allergenes from plants and the medicinal constituents of

plants—both being potential sources of industrial products. The *Agricultural Research Center* has only recently started its operations, which are aimed to supplement or complement the studies in agriculture and natural resources of established agricultural institutions, like the Department of Agriculture and Natural Resources and the U.P. College of Agriculture. It will continue its initial work on the soil aspects of cadang-cadang and the control of rats and other agricultural pests.

The major arms of the NIST's technical services for industry are the *Tests and Standards Laboratories,* the *Scientific Instrumentation Center,* the *Documentation Division,* and a *Laboratory Training Program.* Recently, a *Techno-Economic Staff* was organized.

The *Tests and Standards Laboratories* is considered as the "guardian" of measures, weights and standards of quality. Testing, calibration and standardization of industrial materials and products are among the principal functions. In the past, its activities were concentrated on samples submitted to the NIST, but it is planned to expand this to include the taking of samples from the market for verification purposes. The *Scientific Instrumentation Center* was set up with aid from the United Nations family of organizations. Its objective is to train manpower in glass-blowing, optics, fine mechanics and electronics, for industry's needs. Preliminary studies have been initiated on the fabrication and repair of simple instruments, and it is planned to expand these to the making of science and medical instruments. *The Documentation Division,* along with the NIST's *"Scientific Publication Unit,"* strives to serve the requirements of the scientific community. The "Philippine Journal of Science" and the series of "Philippine Abstracts" and "Bibliographies" are examples of its activities to disseminate scientific researches. Under the *Laboratory Training Program,* the NIST gives on-the-job training to young and qualified graduates in the various disciplines of sciences. These trainees work in the different research centers, and some are farmed out to the laboratories of private firms. This *Program* will be given increasing funds to answer the demands of both private and public laboratories.

The *Techno-Economic Staff* was organized to foster working relationships with industry. Together with the technical men of the Industrial Research Center, it would undertake contractual services or special technical projects for private industry. Examples of this cooperative inplant service to industry were those undertaken for Alpha Dutshe Co., Biac Chemicals Co., and Pacific Ceramics Co.

V

The PHILIPPINE ATOMIC ENERGY COMMISSION — the other research agency of the NSDB — has the mandate to promote and develop atomic energy in the Philippines, emphasizing its uses and application for industry, agriculture and medicine. The establishment of the *Philippine Atomic Research Center* was the major accomplishment of the Commission.

Significant researches were undertaken in biology and medicine, chemistry, nuclear engineering, health physics and agriculture. Seventeen different kinds of radioisotopes were produced. The local fabrication of nuclear instruments was initiated. A training and education program in atomic energy was successfully implemented. Technical and cooperative services to private and public organization were extended. And a $700,000 pre-investment survey on power, including nuclear power, was completed with assistance from the United Nations Development Programmes.

Industrial research activities pursued by the Commission are mostly innovative or adaptive in the use of known nuclear techniques to local manufacturing processes, and exploratory in so far as tapping new ways of utilizing local raw materials or products. Accordingly, its industrial research activities are essentially grouped into two main areas: (1) research and development on the application of atomic energy techniques to local industrial processes; and (2) research and development in the beneficial uses of nuclear radiation.

Researches on the application of nuclear techniques to industry involve mainly the uses of radioisotopes as (a) tracers in flow-rate and material transfer measurement, leak or clog detection, wear study and isotope dilution analysis; and (b) sources of penetrating rays used for measurement and control of density, thickness, non-destructive testing of materials, and the like. Radioisotopes have provided some of the most sensitive and reliable tracing techniques in investigative work, or locating trouble spots in industrial plants and operations. The improvement in the techniques had led to many farreaching applications, some of which not only provide faster, continuous, and more accurate tests, and measurements compared to conventional means but also permit possible measurement and control methods even under extreme conditions of temperatures, pressures and corrosive atmosphere and with delicate nature of materials involved.

The PAEC long-range research activities in radioisotopes techniques will cover the following:

1. development of direct field measurements of moisture and density (compaction) of soils for silting runways, highways, dams and other engineering structures;

2. development of gamma radiography for the determination of the soundness of critical members of steel and concrete structures;

3. engineering feasibility studies on the radio-pasteurization of proper packaging and cold storage of such seasonal farm produce as tomatoes, onions, etc.;

4. studies on the discharge of major rivers and chronological hydrology or dating of the origin of water using tritium technique;

5. studies of siltration of harbors by radioisotope tagging in order to determine the most effective manner of disposing dredged materials;

6. development of radionuclide techniques for measurements of direction and velocity of ground-water movement; and

7. other hydrological applications consisting of determining river and sea bed variations, embankment seepage and deep well logging.

Researches on the beneficial uses of radiation involve the use of large and powerful sources of radiation and complex facilities that are applicable to various uses such as catalyzing chemical reactions, sterilizing medical supplies and preserving foods. In general, the radiation source most commonly used for large scale processing is Cobalt-60.

Uranium is one of the most important radioactive materials to the nuclear industry. The search for uranium mineral is a major activity in a country embarking on nuclear power development. This project on nuclear raw materials prospecting is an extension of the 1963-64 program of nuclear raw materials prospecting and evaluation undertaken in collaboration with the Bureau of Mines under the guidance of an expert from the International Atomic Energy Agency. As a result of this earlier project, it has been established that an aero-radiometric survey of the Philippines is technically justified and presents the only feasible approach to a nuclear raw materials prospecting program on a national scale. Work will include mainly the location of radioactive anomalies by aerial scintillometer and a follow-up ground survey to verify these anomalies on the ground. The survey is proposed to be undertaken jointly by the PAEC, the Bureau of Mines and the Philippine Air Force.

Other industrial reasearch activities not covered in the areas discussed above include: radio-active waste treatment, water pollution control, solar evaporation studies, and instruments development. With regard to this last project, the immediate objective is to develop and fabricate locally electronics and nucleonics instruments and devices for use in research laboratories, clinics, industrial plants, universities and colleges. The long-range objective is the development of specialized skills and training of technicians which may contribute in a large measure to the development of a viable electronics industry in the country. The project, thus, not only provides opportunities for development of local talents but also will lead to dollar conservation and generation of income producing industry.

Some of the instruments and equipment already produced under this project are survey meters, pH meters, scalers, dosimeters, pulse height analyzers, and a set renal scanning equipment for the Rizal Provincial Hospital. Another project related to the development of instruments in a complimentary manner is the Solid State Detector project wherein the local manufacture of diodes and transistor is the primary objective. In this connection, production methods involving vacuum techniques, preparation of thin solid films on metallic or non-metallic supports by vacuum evaporation will also be developed. The knowledge to be gained thereby could lead to the local manufacture of vacuum tubes, transistors, printed circuits, capacitors, and other precision components.

The other research agencies connected with the NSDB are the Philippine Coconut Research Institute, the Philippine Textile Research Institute, the Philippine Inventors Commission, the National Water and Air Pollution Control Commission and the Metals Industry Development Center. They are all relatively new members of the NSDB family, and are not yet in full operation.

With the money from the Special Science Fund, they will be provided with adequate financial support to develop into highly viable and very productive organizations. They represent a new approach to the NSDB's legislative mandate of promoting research and its applications. As I mentioned earlier, the "financial grants-in-aid" was the main technique utilized by the NSDB in pursuance of this mandate. These agencies were organized in line with the new technique, which we call "institution-building".

Under the "institution-building technique", the problem area of top priority is first identified. An assessment is then made on the capacity of existing research organizations to adequately deal with the problem. Should the assessment show the inadequacy of existing institutions, the NSDB will either strengthen the institution or set up a new institution, provide it with the necessary financial and technical manpower inputs, and monitor its effectiveness to deal with the problems it was set up to remedy. Thus, the PHILCORIN was set up to provide the researches needed by the coconut industry; the PTRI, for the textile industry; the PIC for the inventors; the NWAPCC. to remedy and prevent pollution; and the MIDC, for the metals industry.

These then are the "instrument" which may be utilized in our efforts to apply research and development to the socio-economic progress of our country. As NSDB Chairman, I should like to offer these "instruments" for your use in your own efforts to industrialize our country.

VI

In closing, permit me to submit some general recommendations which this Workshop may wish to consider in its discussion on strengthening collaboboration in research between Private Industry and the Government.

First, industrial research should be an integral part of any economic development plan. For instance, the importation of expensive technological processes or expertise could be one factor to be considered. Preference could be given to the import of "processes" rather than the import of "turn-key plants". This will enable local design and engineering organizations to be set up and gain experience which in turn will make possible, in the course of time, the scaling up of the results of indigenous research and their application to the country's development efforts.

Second, the Government should consider sponsoring, subsidizing and even financing any new technology of promise. Likewise, Private Industry should participate directly in the development of a new product or process being undertaken in government laboratories.

Third, communication between the Government and Private Industry should be made more effective, both at the policy-making and implementing levels. Professionals from Private Industry should be encouraged to spend more time in research centers of the government, and research workers of the government in turn should be encouraged to spend some time in industries whenever possible to give them a background of industrial problems and approaches.

Fourth, joint collaboration should be encouraged in market surveys, evaluation of projects requiring research, operations research. I may cite here the NSDB participation in a comprehensive study of the textile industry as one example, and the future role the NSDB will play in the metals industry development.

And fifth, research personnel from both Private Industry and Government should be encouraged to join professional societies where they can exchange ideas and technical information. Perhaps a professional association specifically for industrial research personnel could even be organized.

It is my sincere belief that the enthusiasm and support that have been given by the sponsors of this Workshop are indications of the future collaboration between the Government and Private Industry. I look forward to fruitful and meaningful discussions – and I trust that significant decisions will be made in the next few days to lay down the basis of this collaboration in industrial research.

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DIRECTION FOR INDUSTRIAL RESEARCH IN PHILIPPINE INDUSTRIES

by

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Industrial research, defined for the purpose of this paper, will signify development research designed to yield industrial, manufactured products as distinguished from pure research, technical research and other research which do not generally yield a manufacturable product.

To a very large extent the social and economic problems of the Philippines can be traced to unemployment. The social unrest in certain areas of the country arises from the acute realization of the people of the inequitable distribution of economic goods, with the indigent forming the overwhelming majority and 2% of the population owning 70% of the assets and incomes. The breakdown of law and order at street level can be traced to idle hands and unexpended human energies. The nagging international balance of payments can be traced, through economic cause and effect, to low productivity and low incentives to productivity.

The dimension of unemployment stands at approximately 8.5% of the existing work force totally unemployed and 23% only partially employed. Every year there is a net addition to the work force of approximately 450,000 pairs of hands. Recent breakthroughs in agricultural productivity further complicates the problem, leaving the task of supplying new employment almost completely to industry.

These are the size and shape of the responsibility for employment that industry must carry in the Philippine scene. It is imperative that industry bend every effort in the creation and maintenance of employment if the country is to avoid major social unheaval.

One such effort is industrial research. At this broad and basic policy level we propose that two major criteria be applied to areas for industrial research in the Philippines.

The first is this: Industrial research should be directed towards the development of products which would require labor-intensive processes to manufacture, possibly with a low per capita investment, so that the industry thus generated, whether in the form of expansion of existing organizations or the creation of entirely new enterprises, might confront the unemployment problem.

There is a tendency for industrial research oriented to similar activities in highly-industrialized countries to concentrate on products which are most economically manufactured utilizing economies of scale through highly mechanized and automated procedures. There is strong trend in such industrial research to minimize human labor in favor of the more efficient and less costly

machines. This direction logically comes from the high cost and scarce labor of the fully-employed industrialized communities where individual productivity has begun to reach saturation levels, and where additional labor can be obtained only through importation, with all the social and administrative difficulties connected with such undertaking.

The second criterion should be the development of products whose raw materials are indigenous to the Philippines: phrased differently, the conversion of primary products to secondary or finished products.

While the new activity thereby generated per se might not significantly boost the levels of employment, such a criterion would protect existing employment in agriculture and in the extractive industries.

A case in point is the abaca industry. The plantation and stripping workers in Manila hemp are now losing their means of livelihood. This can be traced almost directly to the fact that no industrial research has produced secondary products using abaca fiber. It has become extremely sensitive to world prices which are beyond control of local producers and in the development of synthetic fibers that have replaced Manila hemp in many of its uses as twine and rope. Industrial research undertaken for the development of abaca could have averted this delineation or at least protected the fiber from substitutes.

On implementation phases, may I submit the recommendation that the marketing aspect of industrial research be discussed in this workshop. I would recommend the creation of a private clearing house to serve as a center for industrial research, effectively functioning as a marketing outlet for industrial research. Such a clearing house would have intimate knowledge of research facilities available in both private organizations and government institutions; industrial, educatonal and scientific. It could place private industrial research studies in portions which could be undertaken by different entities and coordinated by the clearing house where no one entity could have undertaken the entire project by themselves. It could also serve as a research consultant for enterprises who do not have their own research staff and who therefore might not be in a position to quantify and accurately define their research requirements.

At the same time, such a clearing house would be acquainted with work in progress as well as results of industrial research. Where major breakthroughs are achieved, the clearing house can inform industrial firms. By-products which may be irrelevant to the main thrust of the project could assume critical importance to some other industrial activity. Such fallout could be identified and codified by the clearing house for use by other organizations.

In summary, therefore, we propose that two criteria for industrial research in the Philippines be established — to direct research efforts towards the development of products which are labor-intensive and require low per capita investments and the conversion of Philippine primary products to secondary or finished products. We close with the recommendation that an industrial research clearing house be organized on a private basis to mobilize industrial research and geared it to the Philippine industrial environment.

INDUSTRIAL RESEARCH IN PRIVATE INDUSTRY IN THE PHILIPPINES

By the Economic Development Foundation

I.

The main object of any business enterprise is intrinsically economic. Industrial research, as an activity of a business enterprise, supported and financed by it, must therefore be directed at that economic goal.

Industrial research in private industry, however, is only one of the many activities serving the enterprise objective. Unfortunately, industrial research is often considered a long-term process requiring a good measure of financing, and its benefits are usually the fruit of long waiting and patience.

Where an enterprise is short on finances and impatient for some return on its investments, the tendency, therefore, is to concentrate most investment capital available only on activities that immediately — — on a strictly short-term basis — — achieve the economic objective.

For instance, a small manufacturer of radios would rather put his money in importing the component parts that have to be imported, and in selling his radios in a very competitive market, than in developing a new part that will make his radio sets sound better. The reason is as basic as this: his money is so seized up by the high cost of importing components, and the high cost of competing with tax-free smuggled products as well as with legitimate competitors crowding the industry, that if he invested part of his resources in the development of a better radio, he would be out of business within the year.

That, in a nutshell, is the crisis of industrial research in Philippine private industry today.

Research in Individual Companies

Not all companies, however, are as harassed by the tight money and crowded-industry situation as our small radio manufacturer. There do exist some enterprises that are sufficiently financed as some of the papers to be presented in this conference indicate — — so that they can undertake large scale industrial research. Then, some of the many functions of industrial research are so basic to business enterprise that even the smallest company is bound to employ them, even informally.

A cursory review of industrial research — — which this paper proposes to undertake — — must necessarily identify the many functions comprised in the concept.

An enumeration of 10 functions will serve our purpose:

1. Development, improvement or adaptation of production methods, techniques and processes or equipment
2. Market studies
3. Operational research

4. Productivity and project studies
5. Project feasibility studies
6. Quality control
7. Formulation of standards
8. Exploitation and use of raw materials
9. Discovery of new products
10. Pilot scale experiments.

The order of the enumeration is not entirely arbitrary. This was chosen to indicate, based on qualitative experience, the frequency of application within the context of Philippine industry. The first three items enumerated, in particular, are possibly the most widely applied forms of industrial research in the Philippines. Quite noticeably, these research functions can be identified as necessary in terms of immediate business goals. And the returns of these types of research are immediate, if not always directly tangible. A manufacturer, for instance, must necessarily adapt equipment, production methods, techniques and processes to Philippine conditions. If adaptation is not necessary, the possibility of the need must have at least been considered. That is one form of industrial research. The wide application of this type of research is also, to an important extent, due to the equipment suppliers who make it a point to assist buyers in applying the equipment. There is a cut-off point, however, in the extent to which the adaptation will be made. A small manufacturer, normally, would be interested only in getting the manufacturing of products started as early as possible, and adaptation would stop at the point of least sufficiency. Companies with a better financial base would continue even beyond immediate needs.

This type of research is very firmly established in the Philippines. In fact the emphasis given to it is such that institutions of higher learning lately include the most advanced courses in the area as regular offerings in their prospectuses. Agencies undertaking contract market research have proliferated during the past decade and so with individual companies with formal market research departments.

But here again, the larger companies would go into formal, continuing studies of consumer preferences, packaging trends, new market and new product development, the smaller companies might make a simple magazine research as to market size, competing suppliers and prices —jump into the market, and that would be that.

All this tends to illustrate the state and goals of industrial research in the Philippines at this stage of development. It tends to be limited to the essential, the inexpensive, and the expedient in terms of returns.

The very important work being done by individual companies with industrial research programs, however, should not be disregarded. In fact, few as they are, these companies are contributing the bulk of what can be classified as technological research in the country today. Some have their own facilities, and others work partly through facilities of foreign research institutions and laboratories under contract. The extent of the work of some of

these companies will be documented in detail in some of the papers to be presented for discussion. A broad indication of their work is also found in Part II of this paper, which seeks to point out directions for possible future research efforts.

Professional Research Organizations

The industrial research being undertaken by professional research agencies is for practical purposes limited to management services, generally including the first six items previously enumerated in this paper as functions of industrial research. Professional technological services are still limited to a few activities like aerial photogrammetry, pest control research and, recently chemical properties testing which is being undertaken in small scale by a new group.

The limited number of private agencies offering technological and laboratory services, however, is not surprising in view of the apparently timid market for such servces. Two years ago, the EDF engaged the services of Battele Memorial Institute — — one of the world's largest contract research organizations — — in an effort to make its services available to local metallic industries. The approach was to cut down on the cost of hiring Battelle's servcies by letting the EDF undertake literature research and non-technical phases involved, and where possible spreading the cost among a number of firms with common technical problems. Unfortunately, the project did not elicit the expected response. Fear of competition was prominently mentioned as a chief factor in this hesitancy. This, however, is probably the least valid of reasons because of the large market from metal products which far exceeds production.

This hesitancy of the market — — which is unexplainable in view of the vocal need for technological services, is also evident in the current experience of the Metals Industry Development Center. The MIDC is granted by law an appropriation of ₱7.5 million for its operations and the acquisition of testing facilities and equipment. The law provides, however, that the private sector first put up a token contribution in support of the MIDC*. However, after more than two years of promotion, the private sector contribution has failed to meet the minimum required to set the government subsidy into operation.

The experience of MIDC and Battelle presents a strong contrast to the experience of the EDF when it was being organized. The individual contributions of private firms — — in the case of sponsorships which in effect were no-interest — 15 years loans — — amounted to ₱15,000 per company. Yet within a year, a total of ₱350,000 had been put in, which set into effect a Government loan of ₱3-million to support the EDF.

In fact, at present, no less than eight private companies have converted their 15-year loans into outright donations to the EDF.

* Government to contribute ₱1.5 million initially and ₱1 million annually for six succeeding years; private sector to contribute ₱100,000 initially and ₱150,000 annually for six succeeding years.

This phenomenon presents an interesting case in the study of industrial research in the Philippines.

Trade Associations

Associations that are known to be actively engaged in industrial research include the Cement Association of the Philippines, Philippine Sugar Association, Base Metals Association, Coffee and Cacao Institute of the Philippines, and Philippine Petroleum Institute.

In the main, the bulk of the work of trade associations in industrial research is that of providing and disseminating information. The importance of this type of research in the Philippines can not be overemphasized. Due to the lack of a central agency to consolidate and coordinate data gathering activities, these associations fill a real and important need, primarily for the members.

This phase of industrial research, however, could be extended further – to that of developing new processes and techniques, finding new uses of the products of the industry, and financing cooperative research for new products and in pilot plant scale. The Cement Association of the Philippines has already started in this direction.

II. AREAS OF APPLICATION

From the very cursory review of the status of industrial research in private industry in the Philippines today, some meaningful research directions have emerged. These are essentially based on the resources and peculiarities of the Philippines and the technology required to exploit these resources or meet these peculiarities. These directions are best demonstrated by looking into the individual areas of research applications.

Process Research

Where process research is defined as the evolution of a complete manufacturing process, then no significant steps have been made in this direction. There have been, however, a series of innovations in specific processing steps dictated mainly by prevailing local conditions. A complete transplant of technology without even minor modifications would be quite rare. For example, although there are standard techniques for the canning of fruits and vegetables, differing varieties of the same would require different processing times or temperatures. Determination of these operating variables involves a great deal of research and experimental work.

Similarly, in terms of ultimate products, the effects of conditions of humidity, climate, dust and pollination level, are oftentimes important. Humidity, for instance, dictates that our flour mills adjust their processes to come up with a product of desired quality.

A common phenomenon, as far as Philippine furniture exports are concerned, is for these to deteriorate in countries where humidity is different

from ours. For this reason export furniture makers have to set various specifications and standards to minimize the deterioration and warping of their products under foreign conditions.

Raw Materials

Another factor which should consciously influence research is the use of local raw materials as substitutes for the imported variety. A number of industries, at the start of operations, depend heavily on imported raw materials, although there usually are efforts towards eventual procurement of raw material requirements from local sources.

ITEMCOP, a bag-manufacturing firm, used to depend on jute as raw material. In 1958, it undertook intensive studies on the utilization of low-grade ramie fiber. The results of the study showed that locally available ramie, of grades unsuitable for use in the manufacture of wearing apparel and therefore cheaper in price, could be utilized as a substitute.

Then, there is the Bataan Pulp and Paper Mills which is using locally grown bamboo for pulp-making and the proposed Araneta Pulp and Paper Mills which will produce pulp from Philippine soft wood.

Howeever, when the quality of local materials is such that complete substitution is not possible, studies are conducted so that suitable blends are obtained. Oftentimes a compromise is reached through a mixture of imported and local materials. Bacnotan Cement uses local gypsum in combination with the imported type as a cement retarder. Also there are studies underway for mixing locally-mined coal with imported types to arrive at a suitable blend of cooking coal.

Industrial Wastes

Commercial exploitation of industrial wastes and upgrading of by-products into sources of profit is another important research area for Philippine industry. Since any venture which would lead to additional company income is always encouraging, there have been continuous efforts to upgrade by-products and to utilize industrial waste.

In several instances, waste product utilization has resulted in new industries. The paper industry is a case in point. Research studies on the utilization of bagasse, a sugar-mill waste product, led to the establishment of a new industry. Central Azucarera de Bais was the first in the world to conduct research on bagasse as a source of pulp for paper making. Consequently, it became the world's first integrated pulp and paper mill processing bagasse. Today, a number of pulping mills are using bagasse and/or other agricultural wastes, like rice straw, in their operations. At this juncture, mention should also be made of the Paper Industries Corporation of the Philippines which proposes to utilize wood wastes for pulp production.

The feed milling industry also came about as a result of a search for productive outlets of both agricultural and industrial wastes. The feed plant of San Miguel Corporation for instance, produces B-Meg feeds from spent grain and yeasts from its Brewery.

Waste utilization research is not confined, however, to transformation of these wastes into sources of profit. Chemical companies have engaged in research studies for air and water pollution control. These studies led to a reduction of waste or neutralization of the harmful effects of these wastes.

Industrial research might also find a solution to the caustic soda industry's dilemma of chlorine disposal. There is at present a very limited market for chlorine, but an ample market for caustic soda. However, the production of caustic soda results in a chlorine co-product. Thus, due to the problems of chlorine disposal, the caustic soda industry cannot produce as much as the market demands, and despite capability, caustic soda is still imported.

Pilot Scale Studies

Only very few local manufacturing concerns have their own pilot equipment for development work. Many still depend on foreign research firms conducting laboratory and pilot test runs.

Preparatory to establishing a 500-ton copper benefication plant, ore samples from the Consolidated Mines property in Marinduque are shipped to Japan for laboratory and pilot plant bulk tests.

The same is true with Marinduque Mines which will operate the vast laterite nickel-cobalt bearing deposits in Surigao.

Borrowed Technology

At this point, the role of foreign technological developments is worth considering. It is unfortunate that, to a large extent, the application of such technology is blunted due to constraints of patents and the nature of licensing agreements between foreign firms and local subsidiaries. It may benefit local industry, for instance, if foreign parent companies could encourage their subsidiaries to undertake research and development work that would more definitely adapt products — — and even develop new products — — for the specific conditions obtaining in the Philippines. Goodyear took this direction a few years ago when its local research group developed an off-size tire that suited the Philippine jeepney and the conditions under which the jeepney is operated. This, unfortunately, is a rare example.

EPILOGUE

The preceding review of industrial research activities in the Philippines was based primarily on the EDF's actual contact with the various industries during its four years of research operations. More stress was placed on the tenor of research activities than on content. Subsequent papers of individual industries engaged in specific areas of research will probably suffice to indicate the content of research programs. These papers will also give us some background on the problems that cut across industries. Definitely, for instance, problems of lack of laboratory facilities, standards and standard testing equipment, trained technological researchers and allied workers, will be touched. The intention of this paper has been to sketch the setting that will make it possible to see the known problems from a broader perspective.

INDUSTRIAL RESEARCH PROGRAMS IN PUBLIC UNIVERSITIES, WITH EMPHASIS ON THE UNIVERSITY OF THE PHILIPPINES

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Two basic questions arise in connection with the role of public universities in industrial research. First, what type of industrial research should public universities undertake and second, what activities can be included as part of industrial research.

Industrial research is of course conducted by private companies themselves, by industry associations, by consulting firms and professional research organizations, by government agencies, and by schools, both public and private. A definition of the ideal division of labor between these entities would be beyond the scope of this paper, but on the basis alone of the fact that public universities receive a certain amount of support from taxpayer funds, it would be logical to assume that probably the bulk of its research effort should be directly linked to the society's problems. As noted by a group of educators, the public university "... has the responsibility to use knowledge to help solve the problems of the citizens which support it." [1] The importance of industrial research in public universities thus follows directly.

A detailed definition of the scope of industrial research is likewise beyond the scope of this work, but consistent with common usage, it is considered for present purposes to comprehend all kinds of research in all disciplines, which are of use to industry. As such, the definition would include research on type and quality of output, production methods and systems, marketng problems and possibilities, financial requirements, human behavior in industrial organizations, and all other areas of management in industry. Excluded, however, are research projects in agrculture whch nonetheless are often relevant for industrial purposes.

The university can do research in any or all of several capacities. University research institutes may have programs of research covering broad areas of knowledge and not necessarily undertaken for purposes of immediate use. Research programs would be geared, rather, towards the accumulation of a body of research findings essentially as an end in itself. Individual faculty members may do research as a scholarly exercise, or as part of his teaching preparation, or as consultant to government agencies or private industry, and in some instances, even as part of the school's extension and community services — — to service, for example, certain routine needs of industry such as conducting analyses of materials.

University research in the Philippines is of course undertaken in practically all disciplines, of which industrial research accounts for a rather small portion. The bulk of the research effort appears to be directed to the natural and the social sciences, mostly pertaining to the former. And of research geared to practical and immediate uses, agricultural research accounts for the lion's share.

This paper surveys the industrial research now being done in Philippine public universities, as well as the potential which would be realized with the removal of funding and other constraints. Emphasis is placed on the University of the Philippines which, as described in the following section, accounts for most of the research now being done in Philippine public universities.

Public Universities in the Philippines

There are six public universities in the Philippines. Arranged in order of size, these are as follows: (1) University of the Philippines, (2) Mindanao State University, (3) Central Luzon State University, (4) Central Mindanao University, (5) University of Eastern Visayas, and (6) University of Northern Philippines. The University of the Philippines is both the oldest and the largest of the six. Its ₱38.9 million budget is almost thirteen times larger than the budget of the second largest, Mindanao State University, which expects to spend a total of ₱3 million in 1969. Annex A shows further details of the universities' budgets.

Research is only one of the activities of these universities. Primary emphasis continues to be given to teaching, with varying degrees to emphasis given to programs of community service, student development, faculty development, national and regional development, and so on. None of the public universities use a full-fledged system of budgeting and accounting for individual programs. Little effort is made to allocate faculty time, for example, into teaching and research, or to identify the portion of the costs of research institutes which are properly considered as being due to teaching activities. It is impossible, for this reason, to know precisely how much is being spent for research and most other university activities. Data on research projects supported by foundations and other outside sources are also incomplete. However, accepting at face value the figures budgeted for research cited by each school, a figure of 12% is obtained as the portion of university budgets being spent on research.

Research in Public Universities Other Than the University of the Philippines

In terms of absolute amounts, the University of the Philippines accounts for about 93% of the research work being done in all public universities. Of the 7% being done in the other five, very little, if any, is devoted to industrial research. Annex A shows research expenditures budgeted by the six universities. [2]

No industrial research appears to have been done at the Mindanao State University (located in Marawi City) prior to 1968. Its College of Engineering, however, started in 1968 on its plan to undertake (1) quality control studies for industrial enterprises in the Iligan area, (2) hydrological and meteorological studies, and (3) improved low cost rural and urban housing. As noted in Annex A, a total of ₱185,000 has been budgeted for research by Mindanao State.

Central Luzon State University (Munoz, Nueva Ecija) directs its research effort towards agriculture and has done little or no work directly applicable by industry. Its research program is conducted hand in hand with its graduate education program, which is mainly in agriculture, and both are expected to entail ₱42,000 in 1969.

The research program of the University of Eastern Philippines (Catarman, Samar) centers on "agro-meteorological research and allied research work in agricultural economics and production." The sum of ₱47,660 is being set aside for the purpose in 1969.

Central Mindanao University (Cotabato) has a research program in agriculture, for which ₱125,000 is budgeted in 1969. There appears to be no plan for industrial research during the year, however.

The University of Northern Philippines (Vigan, Ilocos Sur) anticipates no expenditures on research for 1969.

Industrial Research in the University of the Philippines

For the more than fifty years since its founding in 1908, the primary objective of the University of the Philippines was "advanced instruction in literature, philosophy, the sciences, and the arts" and "professional and technical training." It was only in January 1961 that the University officially announced a second objective, "to encourage and undertake research and contribute to the growth and dissemination of knowledge." [3]

Research received substantial emphasis during the term of former president Carlos P. Romulo, who announced:

> "Parallel with the growth of the graduate program and exceeding it where community needs dictate, research activity shall be intensified in all units, and, if necessary, in local centers or new institutes to be established for the purpose. Expansion is to be effected by an over-all increase of funds allotted for research, establishing of research institutes and centers, provision for research professorships and instructorships, occasional relief from teaching, the recognition of the status of the researcher, and an adequate incentive plan... Highest priority for research grants will be assigned to projects that relate closely to social and economic plans for development of the government." [4]

In line with this policy, research expenditures of the University have quadrupled, from ₱2.6 million in 1962 to ₱10.3 million in 1967. These figures include total expenses for research institutes (such as the Institute of Economic Development and Research, the Institute of Asian Studies, the

Philippine Eye Research Institute, and others, most of which, as previously noted, also conduct some teaching work) and research support received from outside sources. The National Science Development Board and the Ford and Rockefeller Foundations are among the outside sources of research support.

In addition to obtaining and otherwise providing for financial support, the University has devoted resources to the development of research personnel, the expansion of research facilities and the maintenance of the necessary administrative machinery. These are discussed below.

Research Manpower. The pool of trained manpower in the University of the Philippines is the largest by far in the Philippines: of the 2,046 full time members of the faculty in 1968, there were 199 Ph.D.'s, 575 Masters degree holders and 390 holding the degrees of MD/LLM/DVM/DDM. More than 100, moreover, were then engaged in graduate work both here and abroad. Technicians and administrative staff numbered 531 in 1968.

While the existing faculty-student ratio of 1:8 still requires normal teaching load to be 12 to 15 hours a week, reductions in class work are possible and now more frequent, to allow time for research.

Facilities for Research and Publication. The inauguration on April 24, 1968 of the UP Computer Center provided one of the most significant boosts to research at the University of the Philippines. Only a limited number of desk calculators had previously been available for research purposes, posing a major limitation that was finally overcome with the installation of an IBM 360/40 acquired with Ford Foundation assistance. Technical details of the UP Computer Center equipment are in Annex B. The computer's capacity is already inadequate for certain uses; a further increase would of course result in greater research capability and allow the installation of a time sharing system probably sufficient for most large scale computing needs in the Philippines. The minimal amount thus required is being proposed for Science Fund assistance.

The University library system consists of over half a million volumes which, while relatively small compared with libraries abroad, has nonetheless been described as the best in Southeast Asia. Of direct relevance to industrial research is the availability of about 16,500 volumes in the Engineering Library, 14,000 volumes in the Business Library, 7,600 volumes in the Economics Library, 2,300 volumes in the Geology and Geography Library, and various other specialized collections.

The dissemination of research findings is one of the functions of the recently established University of the Philippines Press. Founded with Rockefeller Foundation assistance, the Press has the basic aim of providing "a concrete and deliberately conceived facility for the encouragement, publication and dissemination of scholarly, creative and scientific volumes, monographs and tracts [which] commercial publishers would not ordinarily undertake to publish." No works which might be classified as being the result of industrial research have been published by the Press thus far, however.

Academic units of the University also have their own publishing programs,

mainly the issuance of periodicals which often contain articles of interest to industry. These include the *Natural and Applied Science Bulletin, The Philippine Review of Business and Economics, Philippine Journal of Public Administration, The U.P Engineer, Forestry Leaves, Philippine Law Journal,* and *Philippine Journal of Veterinary Medicine.* Only the last three regularly include material concerned with production problems and techniques. The other journals ordinarily contain materials useful for planning, marketing, financing, managing, and other activities of industrial organizations.

Research Financing, Administration and Compensation. The University's general funds (obtained from student fees, the national government contribution, net earnings of business units) have been tapped for research expenditures. Extensive support has also been received from foundations and other outside sources. The Ford and Rockefeller Foundations have shouldered large chunks of research costs, as have the National Economic Council — Agency for International Development, the National Science Development Board, national government agencies, and other sources, both local and foreign.

A large part of the University's research funds are allocated by four research councils: (1) Natural Science Research Council (NSRC), (2) Social Science Research Council (SSRC), (3) Community Development Research Council (CDRC), and (4) Labor Research Council (LRC). Funds provided by general University sources and from various other agencies such as the Presidential Arm on Community Development, the Department of Labor, and others, are allocated by these Councils.

Coordination and administration aspects of projects supported by the NSRC and SSRC are undertaken by the Office of Academic Services which is responsible to the President (through the Assistant for Academic Affairs). Projects of the CDRC are conducted by the Council itself, through its Chairman, a practice also adopted by the Labor Research Council.

Research projects are also financed and undertaken directly by academic units of the University. Most colleges and research institutes provide for research programs in their regular budgets or with grants specifically secured for the purpose.

Research work is still often considered as extra work deserving extra compensation, either in terms of reduced teaching load or in terms of research honoraria. Unlike the practice of many schools in the United States, for example, the basic salary of faculty members in the University of the Philippines cover a full twelve-month period. In some American schools, faculty members get a 9-month basic salary and are given the opportunity to earn another three months' salary by rendering extra work in research, summer programs, and so on. A built-in incentive for contract research work thus exists. No book reimbursements are made, either, to compensate the University for any teaching load reductions. Instead, grants sometimes provide for honoraria and paid to the researcher involved.

Industrial Research Projects Supported by University Research Councils

A quick look at the grants made by the four research councils shows that of the 173 projects and project renewals supported by the NSRC and the SSRC over the academic year 1966-69, only 19 seem to be of direct industrial significance. Of these 19, only a handful are directly concerned with industrial production problems. CDRC projects show a similar orientation away from industry, although by its nature, LRC research is related to industry.

In terms of relative emphasis, NSRC and SSRC projects related to industry account for 13.86% of total project grants during the three-year period. Major grants made by the two councils include the following: (1) evaluation of the potential uses of Philippine coals for the metallurgical industries, (2) assessment of heat stress in some industrial operations, (3) studies on the utilization of local phospate deposits for fertilizer manufacture, (4) PI-US tariff relations, (5) sociological-anthropological studies of selected communities in metropolitan Manila, (6) solvent extraction of thiocyanate, choloride, cyanide, and bromide ion, and so on.

The CDRC was established to support investigations meant to facilitate the implementation of the Philippine Community Development Program and has already published the results of twenty six of its investigations. Only one of these, however, "The Ready-Made Clothing Industry in Minglanilla." by Rev. Fr. Richard Arens, SVD, appears to be classifiable also as industrial research.

The LRC was created to assist the Asian Labor Education Center, a unit of the University, in its research program. Council resources have so far been devoted to a long-range study of the labor movement in Asia and a study of the Philippine labor situation. The latter study covers in detail "the status of the Philippine labor force, distribution, occupational composition, migration, utilization, mobility, manpower requirements of key industries, and wage and incentive structures."

Industral Research in Selected Academic Units of the University of the Philippines

1) The College of Engineering. Most of the research in the College of Engineering is being done under the auspices of the U.P. Industrial Research Center (UPIRC) which was established in 1954 to extend "assistance to industry, government entities and the general public in terms of technical and specialized services not available elsewhere in the country. These specialized services include research investigations and consulting work.

Members of the faculty and technical staff of the College of Engineering are simultaneously staff members of the UPIRC, with research and other projects being staffed in accordance with project requirements. Clients are charged all direct costs, including researcher honoraria and a contribution

to College overhead the latter representing depreciation and other general costs.

The laboratory facilities of the college are open to UPIRC undertakings; these include facilities for materials testing, soil mechanics, sanitary engineering, chemical engineering, electrical engineering, mechanical engineering, physical metallurgy, ore dressing, extraction metallurgy, and hydraulics. The College also maintains machine welding-and-forge, wood-and-pattern, and foundry shops.

Equipment is thus available for testing structural materials, soil investigations, photo-elastic studies, experiments in unit operations, heat transmission, unit processes, hydraulics, electronics, circuit analysis, nuclear instrumentations, metallography, ore dressing and extractive metallurgy, fuel testing, and so on. The machine, wood and welding shops are equipped for the fabrication and erection of needed experimental apparatus.

The bulk of the work being done by the UPIRC consists of materials testing, mainly for the construction industry. However, it has done a wide variety of work as may be seen in Annex C.

UPIRC acts on the basis of inquiries received from outside agencies or individuals. It shies away, as a rule, from projects which may compete with professional engineering practice. The lack of internally-activated researches is due partly to a lack of more specialized equipment and funds for operating expenses, as well as to the attractions of professional consulting work which compete heavily for faculty time. A particularly noteworthy need exists for a structural dynamics laboratory, the lack of which prevents much-needed studies of the effects of earthquakes, typhoons and other dynamic factors on buildings and other structures.

A long list of research projects potentially useful to industry has been shelved for at least these major limitations. Judging alone from faculty qualifications (32 Masters degree holders, 3 Ph.D.'s and more to arrive), the yield of additional research funding is potentially great.

2) Forest Products Research Institute. A semi-autonomous unit within the University of the Philippines, the Forest Products Research Institute (FPR) was established in 1917 as a consolidation of the former Forest Products Laboratory and Forest Products Research Section of the Bureau of Forestry. The Institute was created within the University with the thought that coordination with the UP College of Agriculture would be thereby facilitated.

The general purpose of the FPRI is to conduct research on the 3,800 species of Philippine woods, geared mainly towards the problems and needs of the logging, lumber, plywood, pulp and paper, construction, handicraft, and other wood processing industries. As presently organized, FPRI has five technical divisions, each pursuing a delineated research program:

a) The Chemical Investigations Division is responsible for research on the pulp and paper making qualities of wood, as well as its chemical composition and other properties, in order to determine suitability for various uses. Thirty research projects are cur-

rently being undertaken by the Division, including the chemical analyses of hardwoods, bamboo, cogon, and various other agricultural fibrous materials. Also being studied are the chemistry c cellulose, hemicelluloses, and lignin from Philippine woods, a the production of charcoal and tannins. Direct industrial application occurs in the Division's studies of the pulp and paper making possibilities in Philippne wood species, including the chemical properties, production processes and other aspects of pulp and paper making.

b) The Industrial Investigations Division is in general responsible for research on the mechanical properties of wood and for the comparison and evaluation of different species of wood with regard to their behavior during processing operations. The twenty seven research projects currently undertaken by the Division find direct use in the wood industries. Among the projects being currently undertaken are technical and economic surveys of veneer and plywood mills, studies of wood wastes, alternative veneer cutting techniques, the effects of alternative ways of veneer drying and gluing, plywood exposure tests, problems in timber lamination, the identification of wood varieties for specific industrial purposes, the machining properties of Philippine woods, and the bending and finishing properties of selected woods. Technical aspects of logging and lumber manufacture are also part of the Division's work.

c) The responsibility of the Timber Physics and Engineering Division covers investigations and studies on the mechanical and physical properties of all Philippine wood species with respect to structural uses and reliability in construction and manufacture of wood products. Thirty two research projects are now being undertaken by the Division, most of which are directly useful to the construction industry. The strengths of various types of woods used for joints and fastenings are being studied, as are the design and testing of structural members and building components such as trustees. The stresses of structurally important Philippine woods are being investigated, along with alternative ways of housing construction and prefabrication. Packaging materials using Philippine wood and fiberboard are also being studied for durability and strength.

d) The thirty-six projects being undertaken by the Wood Preservation Division deal with types of seasoning processes and mechanics, wood-moisture relationships, wood preservatives, resistance to fire and insects, and studies of wood-decaying fungi.

e) The Wood Technology Division (26 projects) studies wood anatomy as an aid in wood identification, the suitability of specific woods for veneer and plywood manufacture, and ways of utilizing minor forest products.

While nominally under the supervision and control of the University of the Philippines, the Forest Products Research Board serves as the governing body of the Institute. The Board is chaired by the Director of Forestry and the Dean of the UP College of Forestry is ex-officio member. The research program of the Institute is determined by the Board with the assistance of wood-using industries, which are periodically invited to fill out questionnaires on possible research projects.

The annual expenses of FPRI amount to ₱1.1 million and its full time staff members about 230. Funds are appropriated by Congress separate from the government contribution to the University of the Philippines and are not included in the amount shown in Annex A. To supplement its income, the Institute undertakes cooperative projects with individual firms, such as the provision of technical assistance in the improvement of veneer production techniques, and others.

The Institute published its findings in four major report series: *Industrial Reports, Wood Processing News, Technical Notes,* and *Timber Series.* Research output is also often published in the College of Forestry publication, *Forestry Leaves* and in publications of the Department of Agriculture and Natural Resources.

3) *College of Arts and Sciences.* Research work done in the College of Arts and Sciences are for the most part those previously noted as being supported through the Natural Science and Social Science Research Councils. In addition to these, however, special note might be taken of the research activities of the Department of Geology and Geography and the Institute of Applied Geology, which assist the mining industries in mineral exploration.

Major research projects now in progress include (a) geochemical prospecting for copper using arsenic as tracer, (b) sedimentological study of upper miocene deep-sea sands in Luzon and their application to petroleum exploration, (c) studies on the application of geophysical methods for mineral exploration with emphasis on induced polarization (variable frequency), (d) electromagnetic and resistivity surveys, and (e) copper-gold mineralization and quicksilver deposits in certain areas of the Philippines.

These projects are being done without research support, or in cooperation with private firms, or with foundation assistance.

The Department and the Institute maintain laboratories for geochemistry, geophysics, mineralogy, petrology, paleontology, photogeology, x-ray and emission spectography, ore microscopy, and for the preparation of polished and thin sections. Major items of equipment, which are available to industrial users at minimal rents, include induced polarization equipment (sender-receiver generator); an x-ray diffraction and fluorescence unit; an emission spectograph; research petographic, mineralographic and binocular microscopes with accessories and ancillary photomicrograph equipment; and various types of geophysical and other equipment.

Pure research has been the direction of the work being done at the Department of Physics and Chemistry, but special mention may also be made of the research program in the Department of Chemistry. Consisting of 8

Ph.D.'s and 10 M.S. degree holders (with 3 more Ph.D. candidates presently abroad) the chemistry department has unusual capability for industrial research.

A large number of basic research projects are presently underway, but the major industrial research activity of the Department has been the previously noted work on the evaluation of the potential uses of Philippine coal for the metallurgical industries. A major and continuing project over the past three years, this piece of research has concentrated on the physical and chemical characteristics of different coal deposits in the Philippines, including possible ways of improvement through blending and other ways. Malangas coal has been identified by the Department as being the most promising known commercialized deposit. Destructive distillation has also been tried on coal samples, in order to obtain data on possible useful chemical content and other properties.

Research on the utilization of coconut parts has also been done, including studies of ways of oil extraction, the characteristics of coconut shell charcoal, and so on. Related work is being done, moreover, in the Department of Agricultural Chemistry in Los Banos.

Among the pieces of equipment available in the chemistry laboratories are: (1) x-ray diffactometer, (2) spectograph, (3) countercurrent extarctors (100 tubes), (4) polarograph, (5) light photometers, (6) gas chromatograph, and others. A complete radio-isotope laboratory is presently in the process of acquisition as a joint physics-chemistry undertaking. Other equipment, such as an electron microscope, are also being purchased.

Hardly any industrial research is being done in the other Departments of the College of Arts and Sciences, but the Department of Psychology has undertaken attitude survey projects intended for marketing use by various industrial firms. The Department of Botany is also undertaking a study of the protein content of certain types of algae, for possible use as food.

U.P. faculty members are major contributors to national learned journals as well as College publications which include the Natural and Applied Science *Bulletin* and the *Philippine Social Sciences and Humanities Review.*

4) *College of Business Administration.* The Division of Business Research of the College of Business Administration has been engaged for almost four years now in the development of a body of case material on Philippine industrial practice. The case studies prepared cover marketing, production, financial, behavioral, and other administrative aspects of a wide range of Philippine industries.

While basically intended for use as teaching material in its Master of Business Administration program and for use in other schools and companies conducting training programs, the case studies generally disclose much information concerning institutions and management practice in the industries covered. The work thus constitutes both research on, and research for, industry.

Also being written are notes on various aspects of business management. A long range plan includes the possible preparation of industry studies, in-

dicators useful for industrial planning purposes and other projects similarly intended to contribute to management practice and decision-making.

The College and the School of Economics jointly publish *The Philippine Review of Business and Economics* which comes out semi-annually. Case materials are publicly available through the Philippine Case Clearing House, Inc., which acts as a distribution point also for cases prepared by other schools.

5) *School of Economics.* While most of the research done at the School of Economics are intended to be useful at the national planning level, some of the sitxy on-going or completed research work done in 1967-68 are also helpful for company planning purposes. Among these are studies on fertilzer distribution, business concentration, credit criteria, and various studies of national accounts. On at least one occassion, the School did a study in cooperation with an oil compnay, resulting in the work *An Economic Survey of the Limay, Bataan Area,* by Amado A. Castro, James A. Storer and A. Cesar Corvera.

6) *College of Home Economics.* The College conducts research on all its departments which include (a) clothing, home furnishing and crafts merchandising, (b) clothing, textiles and related arts, (c) food and equipment merchandising, (d) nutrition and dietetics. The food packaging and textile industries are thus direct concerns of the College's research thrust.

A pilot food plant is operated by the College as part of its food technology program and is being used for experimentation in the processing and packaging of various types of fruit and fruit products, meats, and other foods. Major gaps still exist in the College's facilities, however, such as a quick freezing unit and other specialized equipment which would allow it to do research over the whole range of food processing and preservation.

Facilities for textile research and experimentation are lacking, however, and have been proposed for possible Science Fund financing.

7) *Other Academic Units.* The wide range of industrial needs makes research in other units also relevant for industrial purposes. The bibliographic work being done by the Library, for example, are important in facilitating industrial research as a whole. The research studies of the Law Center on taxation and commercial law are clearly useful not only for municipal and other judges, but for industry as well. The studies of the Institute of Hygiene on industrial wastes and toxic material are certainly important for the business community. The College of Public Administration's findings on government practice and policy are useful for the business firm that has to deal with the government and with civil servants. The Colleges of Agriculture (and its affiliated institutes), Veterinary Medicine and Fisheries do research work in the commercial processing of agricultural products (which, as noted earlier, have been excluded from the scope of ths paper). The College of Pharmacy does work related to the needs of the drug industry. Studies of the Population Institute, the Statistical Center, and the Institutes of Planning and of Mass Communication are useful in making industrial projections.

A bibliography of the research output of these and other units of the University is published periodically under the title *Research Works and Other*

Publications of the Faculties, the most recent one being (regretfully) for academic years 1961-63.

Problems and Possible Solutions

On the basis of the number of highly trained personnel in the University and on the basis of available research facilities, one wonders why the level of research, industrial research in particular, is no higher. The major difficulties used to be, and to some extent continue to be, (1) the small appropriation for research operating expenses, (2) the heavy teaching load required of the faculty, (3) the low ratio of research-trained people to the total faculty and the fairly sizeable number of these people tied up in administrative and extension work, (4) library facilities, equipment and supplies may be adequate for teaching but are still inadequate for research purposes, and (5) physical barriers to research, particularly the lack of comfortable and quiet office space. [5]

Solutions proposed have included (1) additional outlays for research, (2) reducing the student-faculty ratio even more, to relieve more researchers of teaching responsibilities, (3) the adoption of putting greater weight on publications as a basis for promotions, [6] and (4) the improvement of research administration through the creation of an office of the vice president for research and the organization of an Industrial Research Council (and the abolition of the Industrial Research Center) and a Humanities Research Council in addition to the Natural Science and Social Science Research Councils. [7]

Despite recent gains in research appropriations, in the faculty-student ratio, in staff training, and in research facilities, it seems clear that much additional financing is needed to be able to achieve maximum results in industrial research. While funds and facilities cannot by themselves guarantee research output, it appears that much of these constraints remain major ones.

One encouraging, though two-edged, development is the greater involvement of many faculty members in consultation or extension work with private or public organizations. This is particularly true in the Colleges of Engineering, Business Administration and Public Administration, and some units in the College of Arts and Sciences. Consultation work familiarizes the faculty member with local conditions, with the problems facing local industry and with sources of information. It puts him, moreover, in a much better position to translate into the Philippine setting the principles and theoretical constructs in which he had more often than not been trained. In view of the high salary levels available in industry, one cannot overlook the fact that this opportunity to earn additional remuneration from consulting work in effect constitutes a fringe benefit. Certainly, the possibility of doing consultation work helps reduce the opportunity cost of a university career.

At the same time, however, outside consultation unless adequately controlled cannot help but cut into research time. The competition offered by this more profitable use of a faculty member's time can only lead to a reduction in the priority of university research work.

Funds of course offer the basic solution to this problem. Were enough

funding available, faculty salaries could be sufficiently raised so as to eliminate, or at least reduce, the opportunity costs of doing university work, research in particular. Research funds providing for basic investigator salaries, or the allocated portion thereof, and other direct and allocable costs would most certainly help in achieving this.

The University of the Philippines is in such a state of development that infusions of relatively small amounts can yield substantial benefits. It seems clear that additional expenditures to improve facilities already available (and in many nstances, underutilized) will increase research capability of the country as a whole in an economical manner.

NOTES

1. Hannah, John A., Middlebrook, William T., Reeves, Floyd W., and Hamilton, Thomas H., *A Study of the University of the Philippines* (Quezon City: University of the Philippines, 1958,) p. 4
2. The basic source of this section is Republic of the Philippines, *Budget for Fiscal Year* 1969, pp. 748-767.
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5. Ganzon, Guadalupe F., *et. al.*, "Research Promotion," *University Perspective: Reports of the President's Ad Hos Committees* (Quezon City: University of the Philippines, 1963) mimeographed.
6. *Ibid.*
7. Virata, Enrique T. and Tenmatay, Augusto, "The Research Set-Up in the University of the Philippines," *Development and Planning of the University: Papers and Proceedings of the* 1964 *Faculty Conference* (Quezon City: University of the Philippinies, 1965).

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Annex A. *Estimated Total Expenditures and Research Outlays of Philippine Public Universities, Fiscal Year 1968-69.*

	Total Exps.	Research	% of Total
University of the Philippines	₱38,900,000	₱5,050,000	13.3%
Mindanao State University	3,066,000	185,000	6.0
Central Luzon State University	1,655,000	unspecif.*	—
University of Eastern Philippines	1,076.00	47,660	4.4
Central Mindanao Unversity	1,231,000	125,000	10.5
University of Northern Philippines	606,000	0	0
	₱46,634,000		

* ₱42,0000 was budgeted for graduate education and research. Data from the *President's Budget*, 1969 and from the Internal Budget of the University of the Philippines.

Annex B. *Abbreviated Description of the Characteristics of the Elements of the Configuration of the IBM System/360, Model 40 Computer at the U.P. Computer Center.*

A 2040 Model F Central Processing Unit with 65K 8-bit bytes memory, decimal arithmetic, floating point arithmetic, storage protection, multiplexor channel, two selector channels, and a 1052 Model 007 printer keyboard.

Two printers, one a 1403 Model 002 with 600 line per minute printing speed and the other a 1403 Model N1 printer with 1100 line per minute printing speed.

A 2540 Model 001 card read/punch.

A 2821 Model 005 control unit and a 2841 storage control unit.

Two 2311 Model 001 disk drives which provide random access of storage of 7.25 million bytes per disk drive pack.

Four tape drives: a 2404 Model 001 magnetic tape and control unit with 7-track compatibility, a 2401 Model 001 Magnetic Tape Unit, and a 2402 Model 001 Magnetic Tape Unit. These units have a capacity of handling 22,500 bytes per second or 45,000 decimal digits per second.

Source: Bulletin No. 2 of the Computer Center.

Annex C. *A partial List of Projects Undertaken by the U.P. Industrial Research Center.*

1. Compression testing of concrete samples requested and submitted by private and government agencies.
2. Testing of steel bar samples submitted by private manufacturers and building contractors.
3. Soil investigation and soil test analysis for foundation purposes, requested by private contractors, government agencies and building owners.
4. Chemical analyses of steel samples.
5. Thermal conductivity determination of plastic materials.
6. Foundry analyses of clay samples.
7. Investigation of aluminum alloy for hardness and tensile strength.
8. Study on the strength of concrete mixed with certain additives.
9. Analysis and investigation of the physical properties of cast iron pipes and asbestos cement pipes.
10. Investigation of sand and gravel for construction purposes.
11. Physical property analysis of cement samples.
12. Adjustment and calibration of high and low pressure gauges.
13. Photo-micrograph studies of metal samples.
14. Hardness tests on turbine blades of jet engines.
15. Analysis of the strength of a certain type of roof framing.

16. Calibration of electric current meter equipment.

17. Quantitative determination of the residue of locally manufactured condensers.

18. Capacity and efficiency rating tests of pumps.

19. Electrical resistance tests of a type of dyna-motor.

20. Purification of fish meat for canning purposes.

21. Utilization of coir dust in the manufacture of charcoal briquets.

22. Design and fabrication of a pilot plant for the making of charcoal briquets from coir dust.

23. Spectrographic and metallurgical analyses of steel samples.

Source: The U.P. Industrial Research Centre.

THE RESEARCH AND OTHER INDUSTRY-ORIENTED PROGRAMS IN CHEMISTRY OF THE ATENEO DE MANILA UNIVERSITY

BY MODESTO T. CHUA
Associate Professor

The Department of Chemistry of the Ateneo de Manila University was formed in 1960 out of the then Science Department and had its first baccalaureate graduates in 1964 and its first graduates on the Master's program in 1966. Today the Department is housed in its own building, inaugurated in 1965 on the sprawling Loyola Heights campus of the university.

The building, which was designed by the Department, has a total floor area of 2,156 m^2 and includes four major student laboratories, laboratories for instrumentation and radioactive work, balance room, chemistry library and private office-laboratories for the professors. The service areas include storerooms, a mechanical shop, stockroom and glass-blowing shop.

The chemistry library collection includes the majority of the principal chemical journals, reference works and monographs, and has been enlarged by a recent $20,000 library grant from the Rockefeller Foundation.

The present instrumentation, which is used for research as well as instruction, includes as major equipment, three spectrophotometers (recording Ultraviolet-Visible, Infrared, Atomic Absorption), a Gas Chromatograph, a dual-wavelength Polarimeter, Polarograph, Spectrograph, radiation counters.

At present, the staff consists of six full-time and one parti-time professor, two technicians and a glass blower. Of the Professors, four hold Ph.D and two M.S. degrees. With the current plan to expand the graduate program to the point where a Ph.D. degree in chemistry may be offered, it is hoped to increase the number of the faculty to a total of 16.

RESEARCH PROGRAM

Chemical research in the colleges and universities in the Philippines (which turn out about 300 chemistry graduates a year) has, with very few exceptions, been largely neglected. Of the several factors contributing to this situation, two may be cited, which reflect the short-sighted policies of these institutions and which are important because they serve as effective blocks to any attempt to promote research in the university. One is the fact that many of the professors are employed on a part-time basis, another is that most of these, including those who are on a full-time basis, are simply swamped with excessive teaching loads. This situation makes it difficult for these institutions to attract or hold the really qualified scientists.

The Chemistry Department of the Ateneo is committed to a policy of providing its faculty with the time and the facilities to carry on research along areas of their own choosing. Currently, on the question of research topic,

there is strong feeling among the faculty to concentrate on what may, perhaps, be called "applied basic research", i.e. research that has more immediate relevance to the particular problems and opportunities in the country, associated with its developing industry or with the availability of certain exploitable by-products or natural resources.

In addition to the benefits to development this focussing on local problems and opportunities would make the students, who are necessarily involved in these research projects, aware of the posibilities and rewards for doing chemical research, whether applied or basic, in this country and thus help to provide a pool of Filipino scientists actively engaged in research on the problems of local industries. For, although it has been possible to start and operate our present industries based on imported technologies with the aid of foreign technicians, it seems clear that in the long run, Filipino technological and scientific capability is needed to provide the innovations and adaptations that are required for self-sustaining growth. Increasing contribution from the universities will accelerate acceptance by the industries of their vital stake in the universities' activity and of the necessity of support for these institutions.

The current research topics being worked on in the Department of Chemistry of the Ateneo may be summarized as follows:

1. *Natural Products Research, a reseacrh on the constituents of indigenous plants.*

Very little chemical work has been done on Philippine flora, in spite of the fact that these are likely sources of useful drugs or of suitable starting materials for drug synthesis. Many local plants are known to be physiologically active, some being used as medicament, others as fish-poison, arrow-poison and the like. This study looks into the alkaloidal and non-nitrogenous constituents of selected species (currently of the families Rhamnaceae, Rutaceae and Anonaceae). For nuclear magnetic resonance, mass spectral and other data, for which the required instruments are not available in the Philippines, samples are sent to the Institute of Organic Chemistry, University of Bonn, Germany.

2. *Kinetics of Photochemical Reactions.*

a) The quantum yield of the photolysis of persulfate ion in water. Ultra-violet light (2537 A) absorbed by the persulfate ion ($S_2O_8=$) in water ruptures its peroxide bond, forming two sulfate radicals, which eventually recombine or oxidize water or any suitable substrate in the solution. In dilute solutions of persulfate, where the number of quanta absorbed is directly proportional to the persulfate concentration, the quantum yield is found to be 0.85. This means that after absorbing a quantum of 2537 A ultraviolet light, the probability of a persulfate ion disappearing as such is 85%.

b) The chloroacetic acid actinometer at low concentration. Chloroacetic acid solutions in water have long been used as actinometer

solutions in the ultraviolet region. However, it is usually used in high (0.5 -2M) concentration. It has been found that the quantum yield of the ultraviolet activated hydrolysis of chloroacetic acid remains constant from 0.5M down to 0.05M, making it a suitable actinometer for relatively transparent solutions at 2537 A.

c) Kinetics of the photolytically-induced oxidation of isopropanol by persulfate ion in aqueous solution.

The rate and rate law which govern the reaction between persulfate ion and isopropanol induced by 2537 A UV light is being investigated by a spectrophotometry. The product of the reaction is acetone. All indications point to a free-radical chain process.

3. *Ultravoilet-light sensitivity of economically important Philippine materials.*

Philippine materials of economic importance – like coconut oil derivatives ("cocoplas", for example) will be subjected to UV-light and changes in physical and chemical properties will be investigated by various instrumental methods like gas chromatography, polarimetry, infrared and ultraviolet spectrophotometry.

4. *Development of inexpensive laboratory instrumentation (ongoing project of the Ateneo).*

Many Philippine schools do not have the money to buy expensive laboratory instruments, therefore, we are always alert to the possibility of producing them locally. So far, many pieces of glass equipment have been designed and made. We are currently looking at the possibility of producing local components for radiochemistry in cooperation with the Philippine Atomic Research Center and the Radioisotope Society of the Philippines.

5. *Synthesis of and infrared spectroscopic study of the azomethine dreivatives of 2-hydroxy-3-formyl-oc-tetralone.*

This study investigates the competitive intramolecular hydrogen bonding in these compounds to gain insight into the interrelationship between types of functional groups, electron density and chemical reactivity. The absorption by the carbonyl group of infrared radiation of certain wavelengths is used as measure of the equilibrium condition.

6. *A study of the long-range coupling in 5fluoro-salicylaldehyde-imines.*

The possibility of using the long-range coupling effect between the aldehydic proton and the fluorine atom in this compound in evaluating intramolecular hydrogen bonding is investigated. The synthesized com-

pounds will be sent to an outside institute for the fluorine resonance spectra.

7. *Synthesis and study of the photochemically-induced ring-closure of trans, trans-1, 2, 3, 4-tetramethylbutadiene.*

The stereospecific synthesis of this compound and the rate of the photochemical reaction are of interest.

8. *An Investigation of the cis-trans Isomerism of 9, 10-Dihydroxy-dicarboxy-phenanthrene.*

Literature reports the existence of a cis and trans form of this compound . It is believed, however, that what is reported as the cis form is actually another trans isomer, and the goal of this investigation is to synthesize and characterize the true cis form.

INDUSTRY-ORIENTED PROGRAMS

In addition to the baccalaureate and gradute programs in chemistry, the Department provides three types of industry-oriented programs. These programs, which are offered for chemists already working in industrial laboratories, are the industrial seminar, the industrial training program and consultation on industrial problems.

INDUSTRIAL SEMINARS

The Department periodically holds seminars on modern analytical methods. For the convenience of the participants, these seminars, which are in the form of a series of ten lectures with demonstrations, are given in the evenings. The response to these has been quite favorable. Up to the present, seminars on the following topics have been held:

Topic	*Participant*
1. Infrared spectroscopy	22 participants from 22 industries
2. Gas Chromatography	14 participants from 8 industries
3. Atomic Absorption Spectrophotometry	11 participants from 24 companies

In pursuance of this program, a seminar-workshop on the principles and applications of spectroscopic methods (infrared, nuclear magnetic resonance and mass spectrometry) is scheduled for summer of this year (1969). Since only a few companies have infrared instruments and none at all have instruments for the other two methods, the objective of this seminar is limited to

making industrial chemists aware of the analytical potential of these techniques. This seminar-workshop will also be especially recommended to teachers in colleges and universities.

INDUSTRIAL TRAINING PROGRAM

In response to more specific needs of some industries, the Department also provides a training and refresher program where the technical personnel of the company concerned undergo training in particular techniques as applied to their own problems, or are given lectures in selected areas.

To date two companies have been serviced by this program. In one case, six laboratory technicians were trained on the use of infrared spectroscopy and gas chormatography in laboratory analysis. Emphasis was on the proficiency in the use of these instruments and awareness of associated analytical parameters. In another case, the quality control personnel of a drug company was given a refresher course, consisting of 10-hour lectures in each of analytical ,organic and physical chemistry.

CONSULTATION ON INDUSTRIAL PROBLEMS

The department especially welcomes opportunities to help out in the solution of industrial problems within its competence. Some of this consultation activity involves work that is better characterized as short-term non-routine laboratory research. Among the industries and government institutions that have been serviced are the following:

— drug
— vitreous china
— tin reclaiming
— caustic soda
— textile dyeing
— the Chemical Research Laboratory of the NSDB
— the Philippine Atomic Energy Commission

The response to these industry-oriented programs has been favorable. This is reflected, for instance, in the increasing frequency with which the Department is consulted on industrial problems.

FEATURE PLANS

1. The Department is in the process of reappraising its basic chemistry curriculum in the light, among others, of the needs of Philippine industry, in so far as they can be surmised. An early result of this reappraisal, for instance, is a proposal to replace the present "one-stream" set-up with a "two stream" undergraduate chemistry curriculum. Up till now, the chief goal of the baccalaureate chemistry program has been to prepare the students for graduate school, through a curriculum designed to be equal to those of better colleges and universities abroad. An indication of the success of this pro-

gram, in its present form, is the outstanding performance of our graduates who have gone on to graduate school in the United States, the majority of them being able to win graduate assistantships.

Nevertheless, it is now felt that, in addition to this one stream leading to graduate studies, a second stream emphasizing (in the last year) aspects of chemistry more directly applicable to industry must be initiated. Among the topic being considered for inclusion are quality control procedures, laboratory management, industrial analytical methods, techniques of group research. These essentially industrial courses will be so scheduled that it would be possible and convenient for industrial chemists to attend them as refresher or "retread" courses.

2. With the increasingly urgent need for the developing industry to engage in applied and developmental research, if it is to be viable and competitive, there is a concurrent need for at least one local institution running an active program of graduate studies in chemistry, one that is at the same time a center of excellence, to be able to attract top-notch faculty and students, and also one that must be highly responsive to the needs of our industries. To our mind, the Chemistry Department of the Ateneo represents a solid foundation upon which such a program preferably leading to a Ph.D. degree, could be built. With the presently available fund and facilities, this must still remain in the realm of hope, but a hope that could easily be realized if some form of cooperation with industry, which would be the chief beneficiary of such program, could be achieved.

RESEARCH EFFORTS OF ESFAC*

BY J. G. DAVIDE**

INTRODUCTION:

As a background to this discussion of ESFAC research activities, I believe that it will be of relevance to the subject to review the nature of the company's business. ESFAC is primarily engaged in the production and marketing of fertilizers and agricultural chemicals to meet the needs of Philippine agriculture for these products. Some intermediate products and co-products of the process of fertilizer manufacture such as CO_2, acids, ammonia, gypsum, and iron pyrites calcines are channelled to other industries. ESFAC, and for that matter, the fertilizer industry in general represents an excellent example of the interdependence between agriculture and industry. Success in the fertilizer industry is tied with the progress made in agriculture. The more progressive and productive agriculture becomes the more benefit industrial companies stand to gain.

Modern improvements in agriculture are the direct results of research, and the necessary inputs for such improvements are supplied by industry. The development and growth of the fertilizer industry stemmed almost entirely from the research of Sir John Lawes of England in 1840 when he proved that superphosphate could be made from rock phosphate with sulfuric acid; and also from the discovery of a means of extracting nitrogen from the atmosphere and converting it into a form which could be used as a plant food, which was accomplished by Bayer and others during the early years of the 19th century and later.

In highly developed agricultural ceonomics, agricultural and industrial research has revolutionized agricultural practices. For example, through agricultural research, knowledge of soils, climate, new methods of diagnosing plant and soil needs, plant nutrition, and new methods of applying fertilizers were developed. Along with this, industry conducted research on the development of new fertilizer compounds and combination, insecticides, fungicides, herbicides, agricultural machinery, etc.

The fertilizer industry is an outgrowth of the need created by agricultural research's findings of how to increase the productivity of the soil. In meeting this need, the industry has, in turn, used research as a tool to develop new, improved or upgraded products, better processes and technology to replace the conventional and commonplace. Industry has also striven to find better ways to efficiently distribute and market its products.

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ESFAC RESEARCH ACTIVITIES

ESFAC's research program is tailored to the needs of its business objectives and covers a full range of activities – from the basic conception of an idea through its development and application. As mentioned earlier, ESFAC business includes manufacturing and marketing. In order to be efficient in both operations, ESFAC has to depend on research. The areas of research carried out at ESFAC falls under the following categories:

- Production Research which includes product development, finding better processing technology, evaluating new materials, quality control. This approach is along a product line concept.
- Marketing Research to determine the profile of the market, the best way is to develop the market, new markets and new products.
- Marketing Services Research to determine the most effective advertising sales promotions and extension communication techniques.
- Agronomic Research to test new agricultural products, find better methods of application, to assess nutrient requirements of various crops, soils and cultural practices. Effective fertilizer use demands a thorough knowledge of the type of fertilizer most effective under the given agronomic conditions, and of their proper use for given soils and crops. Knowledge of these variables is one of the pre-requisites in any attempt to promote fertilizer usage as a means of increasing crop production and farm income. Agronomic research and demonstrations are the means to obtain these data and at the same time awaken the farmer to the benefits of fertilizer.
- Operational Research to find a technique of improving the efficiency of management of the entire company business.

ESFAC has at its disposal an array of research resources and manpower. Although ESFAC has a Business Planning group which undertakes market and operational research activities of a corporate nature, its organizational structure does not include personnel specifically responsible to conduct research *per se* nor has it a research laboratory as such. ESFAC, as one of the affiliated companies of Standard Oil Company (New Jersey), relies on its sister company, Esso Research and Engineering Company, in the U.S. to provide its research and technical services to the worldwide Esso affiliated companies. ESFAC's product development and processing technology research as well as some of its basic agronomic research projects are carried out in close coordination with Esso Research and Engineering Company, and has the benefits of the full time scientists and engineers and the modern research tools available at Esso-Research.

ESFAC has carried out extensive work aimed at developing a knowledge of the market for agricultural products. Before deciding to enter any market, it is necessary to know the characteristics of that market – its size, rate of growth, factors affecting its growth and the present and future demand-supply situation. ESFAC conducted four detailed market research studies. The first in 1961 was a preliminary efforts; the second was in 1962 which served as the basis for deciding to invest in a fertilizing plant and the types of ferti-

lizer to produce; and the third was in 1964, the purpose of which was to gather more information on fertilizer usage throughout the country, extent of fertilizer usage by crops and by regions, characteristics of farmers who use fertilizers and those who do not; and to determine the factors restricting wider usage of fertilizers by farmers. Again in 1968, a detailed study of the market and forecast of its growth was made. The results of such studies form the basis of ESFAC's marketing organization, marketing plans and approach and the formulation of programs for market development.

Along with the marketing research, chemist and engineers were occupied in the laboratories and in the pilot plants of Esso Research and Engineering evaluating different manufacturing processes and raw materials, testing product specifications and quality.

Studies were also conducted to determine the best methods of packaging ESFAC's products and assessing the various types of packaging material that would be economical and would stand rough handling involved in transhipment by various modes of transportation which are used in this country. As new packaging materials have become available, further packaging testing studies are being carried out.

As part of our effort to increase fertilizer usage in the Philippines we have carried out a number of promotional and agricultural extension programs. Naturally, we have tried to measure the effectiveness of these programs. Research is a continuing operation. One characteristic of a good researchers is that he is not satisfied with the *status quo*. Each attack on a problem penetrates deeper than the previous attempt. Well, in the earlier market studies, the lack of adequate knowledge about fertilizer, its use and the benefits that can be derived from it showed up clearly as the major reason for non-fertilizer usage among farmers. ESFAC launched an extensive farm demonstration program throughout the country to show the effectiveness of fertilization on various crops. These demonstrations were carried out in cooperation with farmer-cooperators. Farmers meetings and field tours were conducted during each of these demonstrations to try to convince as many farmers as possible of the effectiveness of fertilization programs. A year after the implementation of the demonstration program, a study was conducted to try to obtain a quantitative measure of the effectiveness of farm demonstration as an extension tool; to determine how the program has improved farmers knowledge and attitude regarding fertilizer usage, improved farming practices; and to find how the program has influenced the sales of ESFAC products.

The findings of this study show that: (a) farmers who attended farm demonstrations are generally better informed on Engro fertilizers, pesticides, and the Esso Agroservice than non-attendees; (b) farm demonstration attendees used more fertilizers than non-attendees; the average consumption for 1966 of attendees was 11.2 bags vs. 7.9 bags for non-attendees; (c) of the 190 farmers interviewed, 47 were not using fertilizers prior to having attended field days. Of these 47 potential consumers, 15 have started using fertilizers and 23 will become users in the current crop year. The conclusion drawn from the study was that farm demonstration is an effective educational and

marketing tool as well as a means for developing brand preference in favor of ESFAC products.

One of the factors shaping the development in our rural areas is the introduction of transistor radios — this has become a status symbol in the farm population. A UNESCO study show that the Philippines has the most radios today in Southeast Asia — 39 for every 1,000 people. ESFAC recognized that the radio can play an important role in our farmers educational campaign. It therefore, has instituted a radio farm program throughout the country to bring to the farmers the latest information on improved farming practices, results of the farm demonstrations and current events. A year after the program was implemented, a study was conducted to determine its effectiveness and to find ways of improving the program at a minimum cost to the company.

Results obtained from the study showed greater awareness among radio owners of the fertilizers and pesticide products of ESFAC. Eighty percent radio owners interviewed were fertilizer users compared to 57% fertilizer users who were non-radio owners. The significance of radio ownership on fertilizer usage was more pronounced in relatively underdeveloped market as shown in the results of the Bicol sample compared to the Southern Tagalog. The difference in fertilizer usage was more marked in Bicol between the radio owners and non-owners.

A study of the effectiveness of our Advertising and Sales Promotion is currently in progress. The objectives of this research are: (a) to evaluate the effects among farmers of the advertising and sales promotion campaigns conducted by ESFAC since 1966 in order to obtain a benchmark against which succeeding efforts could be measured; and (b) to gather insights into the pertinent habits, attitudes and opinions of farmers and the processes of their decision-making as a basis for formulating future advertising and sales promotion plans.

As agriculture moves from the traditional to modern scientific farming, farmers require more and more, products that can help solve his farm problems. To this end, industrial and agricultural researchers have continued their efforts cooperatively in the quest of new ideas, new products and better ways to get things done. When new products are developed, they have to undergo rigid and critical tests to assess the performance of the product under actual field condition.

ESFAC's current agronomic research work includes activities in each of the following areas:

Product testing. A product that reaches the market has generally undergone a long, tedious process of research following from the conception of the idea. This includes laboratory synthesis, screening and testing. Of the compounds that chemists found promising in the laboratory, only a small percentage ever reach full-scale trials. Those compounds which reach full scale trials will have to prove that they can give the desired benefits so that farmers who use them will be assured of a satisfactory return on his investment. Many new fertilizer and agricultural chemical products have been synthesized at Esso Research and Engineering and field tested all over the world. ESFAC is respon-

sible for testing or sponsoring the testing by universities and institutes of the efficiency of these new products under Philippine climatic and geographical conditions.

In addition, ESFAC has undertaken a massive effort to assess the nutritional requirements of Philippine crops under various soil, climatic, and management conditions.

Fertilizer, while known since 1840, is a relatively new technological input in Philippine agriculture. To realize the full efficiency of fertilizers, we need to have information and data on the nutritional requirements of the crops grown under our conditions. Likewise we need to know the fertility status of the soils on which these crops are to be grown. A study by ESFAC of agronomic research results available in the Philippines has shown that very little information is available. Hence, ESFAC has initiated a research program to gain knowledge on the fertilizer needs of the various crops. Such information will be helpful in the formulation of new fertilizers that will meet specific crop and soil needs.

Another area of ESFAC agronomic research program is fertilizer management to find better method of fertilizer application and the proper timing of its application. Included in this type of research is our cooperative project with IRRI to evaluate nitrogen fertilizer sources, method and time of application on rice and the projects with PHILSUGIN and Victorias Milling Company on sugarcane fertilization studies.

With intensive farming such as being done increasingly in the Philippines, soils can be depleted of certain elements called micronutrients. Micronutrient deficiency will result in stunted growth. For normal growth, such micronutrient deficiencies must be discovered and remedied. The main emphasis of the Philippine fertilizer industry today is on the three primary plant foods—nitrogen, phosphorus and potassium. This is so because these are the plant foods most critical in many soils, and are the ones which plants require in large quantities. But the micronutrient elements are as essential to the growth of plants as vitamins are in human nutrition. We do not have enough information as regards their supply in the soil. ESFAC has, therefore, undertaken a research effort to assess the micronutrient status of Philippine soils. This research is done in cooperation with the U.P. College of Agriculture, and Esso Research and Engineering Company.

Fishpond fertilization has also received much attention recently because dramatic results on fish growth can be obtained by proper fertilization. ESFAC is, therefore, conducting a study now with the Fisheries Section of the Bureau of Vocational Education to determine the best fertilizer management of fishponds.

We have also undertaken a program of study on the agricultural use of gypsum. Gypsum, a co-product of ESFAC's manufacture of phosporic acid, is now being processed for use by the cement industry. However, because of its calcium and sulfur content, gypsum has some value as a plant food and we have a research project undertaken to determine the agricultural value of this product as a source of sulfur and calcium for crops.

All the agronomic projects which I have just mentioned are conducted by ESFAC on a cooperative basis with government and private research institutions and in conjunction with the Esso Research and Engineering Company.

We have many other research projects which are being planned. For example, one of the services that ESFAC provides to farmers is soil analysis or soil testing. ESFAC established a soil testing laboratory at Pasig to handle the chemical analysis of soil samples submitted by farmers in order to determine the fertility level of his soil. On this basis, a sound fertilizer recommendation tailored to the needs of specific soils and crops can be formulated. In order to improve this type of service ESFAC is considering a study: (1) to determine how well soil testing meets the needs of the farmer; (2) to determine the effect of soil testing service in increasing fertilizer sales volume; (3) to determine the dominant nutrient ratios recommended for each crop at a given fertility level for each application.

ESFAC is also concerned with the improvement of the efficiency of the management of its business. One of the means available to achieve this end is operations research or the use of quantitative techniques of management science.

We are developing a mathematical model of our business for corporate planning purposes. This will help us forecast future sales, manufacturing product slates, costs, and other related data. With this model and using a linear programming technique and electronic computer processing, we hope to gain insights into optimum conditions for operating our company. We have further plans to use the electronic computer in sales forecasting and in scheduling to minimize the costs of bringing our products to our customers.

We in ESFAC feel that we have a responsibility in supplying the chemical needs of Philippine agriculture. We can fulfill the responsibility and make a contribution to the Philippine economy only by running our business efficiently. Operations research is one of the tools that will give us the insight to do this.

SUMMARY:

In this paper we discussed the role that research is playing in ESFAC's business and the present research work being done by ESFAC. It is our challenge to increase the effectiveness of our research efforts in support of our current business operations, to permit our manufacturing and processes to operate at maximum efficiency and to have our product lines fully competitive in range, quality and cost. Also, our research mission accept the responsibility for providing proprietary products and technology needed for future growth in product diversity to expand our business in the future. Through our research efforts with agricultural products, we hope not only to add new knowledge in agriculture but also to provide better service to the Filipino farmers.

RESEARCH PROGRAM AND FACILITIES AT DOLE PHILIPPINES, INC.

BY GERONIMO Z. VELASCO

The Dole Philippines, Inc. policy on research, like that of any new industrial undertaking, is to define and solve problems which threaten its success, to maintain or improve the quality of its products and to develop methods and products which will improve its earnings.

Mr. David Bell, Vice President of Ford Foundation's International Division, in a press conference on April 5, 1968, said that the purpose of the joint Ford-Rockefeller Foundation Research "centers is twofold: to apply first class scientific talent to the technical problems of producing more food and to get the results of that scientific research applied in practice". Our purpose is similar but we add new product development, and quality improvement.

We believe that research in foods must begin in the field where the food crop is grown and continue through processing until the final, wholesome, attractive, uniform and desirable product is ready sale. Although our emphasis must be on applied science, some basic or exploratory science is necessary to build a sound foundation. In pursuit of this principle, Dole Philippines, Inc. carries on some cooperative projects with the University of the Philippines on variety testing of corn and other crops and with Silliman University on poisonous range plants and animal diseases. Our scientists have presented papers before scientific societies namely, the Philippine Phytopathological society and the weed science society of the Philippines.

To mention some of our problems may illustrate the need for research and the direction our research is taking. It must be kept in mind that research on pineapple has gone on in Hawaii principally at the pineapple research institute, for over 40 years and that there is a tremendous amount of basic and applicable information at hand. Some of our work is really adaptive research. This, of course, is true to some extent for any major food crop.

We have learned that the established practices in pineapple growing in Hawaii are not always satisfactory on Mindanao. Our soils are different in texture and fertility. Our yearly average temperature is somewhat higher. Our daylight hours are shorter during the warmer part of the year. Our rainfall distribution and average cloud cover are different. All this means that on Mindanao plants grow faster, store less energy from sunlight, and can be made to produce fruit in a shorter time than in Hawaii. This, in turn, coupled with our native soil fertility, means that the best composition and frequency of fertilizer applications must be laboriously learned through evaluation of the factors involved and experimentation to test the accuracy of theory and observations.

Pineapple plants grow very slowly when the temperature is 20°C. They cease growth below 18°C. Growth is associated with respiration. And respira-

tion, as in any living organism, requires an energy source. In pineapple this source is largely sugar. Since sugar is manufactured by the leaves only during daylight, night temperatures above 20°C cause the plant to burn up much of the sugar it produced during the day. The result of this is very little surplus for storage to be used later for filling the fruit and producing suckers which produce the second, or ratoon crop. Thus, our high average temperatures throughout the 24 hours of the day produce rapid growth, but little storage of energy with the result that yield is low and quality is less than desired. In Hawaii, which is roughly 1000 miles farther from the equator, the night temperatures are frequently well below 20°C which means that pineaple growth is slower and the storage of carbohydrate is greater. The average time required to produce a crop of fruit in Hawaii is about 21 months. At our plantation on Mindanao it is about 16 months. In one respect this is very good because it means more efficient use of land and machinery. However, it means that special ways must be found to increase the rate at which sugars are formed, or to decrease the respiration rate, if we are to have high yields and the best quality. The task is made more difficult because our day length is short as compared with Hawaii. Hawaii has about 14.5 hours of sunlight on the longest day. Our longest day has 12.5 hours of sunlight. This doesn't sound like a big difference, but it is 16%. Furthermore, the longest days come in Hawaii during the warmest part of the year when there is little cloudy weather. Our longest days come when we are likely to have more clouds. Therefore, under our conditions the respiration rate is highest when photosynthesis is limited. Obviously, the answer to this problem is to increase the utilization of light by proper plant spacing, and maximum production of chlorophyll in leaves, or to reduce the growth and respiration rate. Plant spacing within efficient limits sound easy, but there are some complications, such as efficient use of land, labor and equipment, and greater difficulty in forcing to flower. Maximum production of chlorophyll can only be attained by experimenting with major and minor fertilizer elements with regard to amounts, ratios and timing. Reduction in growth rates and respiration requires completely new approaches. There are possibilities among the chemicals available, but there are no scientific road maps to lead us to this objective.

At the Dolefil plantation, pineapple plants will not bear fruit unless forced to flower by application of chemicals at the right time. This is good in that it is possible to harvest fruit every month of the year, thus reducing the size of the cannery and amount of equipment below that needed for seasonal harvest. It offers steady rather than seasonal employment for our people. But it also brings serous problems. Chemical agents which readily force plants to flower in Hawaii do not do so regularly at Dolefil. The most expensive methods must be employed. Research is necessary to learn why this is so and to develop better and less expensive methods. We believe that what we find in these areas of study may have application in other crops such as mango.

Weeds are a major problem and their control requires constant effort and

great expense. Herbicides which control weeds very well in Hawaii are unable to do so at Dolefil. We have performed a great many experiments with herbicides, their composition, combinations and timing. We now believe we can get better weed control for less cost. Some of the new methods will be useful on other crops and should eventually ease the weed control burden.

The method of fertilizing according to the need of the plant was established for pineapple in Hawaii many years ago and is used with various degrees of success in other pineapple areas. Leaves are taken from predetermined stations at monthly intervals and analyzed for necessary fertilizer elements. Fertilizers are then applied to the fields to maintain levels which are known to promote good growth. These levels are called critical levels. Unfortunately, critical levels for one area and season do not necessarily apply to another, nor to all growth stages. For instance, phosphorus levels around .01% of fresh weight are satisfactory for growth but inadequate for fruiting, where as the level for magnesium needs to be higher during growth than a fruiting stage. Again, iron in Hawaii must be at 8 to 10 parts per million or iron deficiency symptoms and poor growth result. In our plantation no iron deficiency symptoms are present and growth is rapid even when the iron content is only 2.5 to 3 parts per million. A major job before US is to determine the critical levels of nutrient elements under our conditions. We are also engaged in an attempt to select plants which will produce more and better fruit under our conditions. Almost certainly when, we have them we will need to revise our critical levels chart and our fertilization procedures.

We must know how to prevent erosion of our top soils and excessive leaching of our mineral nutrients. This will be done through research on soil management and adequate fertilization. The problem is difficult, but we are confident that scientific research will solve it. The principles evolved should relate to agriculture in general.

We know from the history of intensive single crop production in other lands that plant disease and insect problems are likely to become more serious. To offset this, we are studying the nematode populations now present, their rate of increase and appropriate methods to control them. We maintain a crew of trained men whose job it is to continuously survey and record mealybug and ant infestations and carry on experiments to learn how best to control them. We will not use any chemical which may in any way produce an undesirable or potentially poisonous residue.

Dole labels have stood for highest quality since Mr. James Dole established the policy 40 years ago that the pineapple pack should maintain the highest quality it is possible to produce. Dole Philippines, Inc. intends to live up to that policy. To do so requires untiring quality control research in the cannery and in the field to produce fruit worthy of the confidence of our customers. In the field this means studies of all the factors that go into keeping plants healthy. Proper mineral fertilization, proper timing of forcing and harvest, proper control of diseases and insects, proper handling before and during processing and, finally, proper analyses and storage of the product are

the results of continuous scientific research and intelligent use of accumulated data and informed observation.

I have talked mostly about pineapple problems and our research efforts on them. We have other crops including coffee, cassava, coconuts, and corn at present. We also have small plantings of cacao, mango, macadamia nuts, avocado and vegetables. Considerable work is being done by the research people on coffee problems, particularly on control of coffee rust, which is a funguous disease that destroys leaves, and on weed problems. Some work has been done as mentioned earlier on variety selection in corn. Our ranch, is primarily devoted to fattening cattle for market, using cattle feed derived from pineapple fruit wastes. It has problems with weeds and fertilization in pastures. We are working on these in an effort to find the most economical satisfactory methods. Research on all of these things is not limited to the research department. Variety trials, fertilizer tests and economic feasibility studies are continuously carried on by the diversified crops department, the ranch and the pineapple department. The ranch also has a cattle breeding project to up-grade the cattle in Mindanao. The results of these studies may in the long run be of as much value to the community as to our company, and we hope that they will be.

At Dole Philippines, we are also looking into how best to market our products. Must we put all our pineapple in cans or should we sell some of it as fresh fruit with equal or better profit margin?

As you are probably aware, Japan imports approximately US $9 million worth of fresh pineapple mostly from Taiwan, and a small volume from Okinawa, Hawaii and the Philippines. Taiwan has the advantage of low production cost and low freight rates. How then can we expect to compete with Taiwan?

Our answer, after a thorough market study is to sell a better quality fresh pineapple through an existing efficient distribution system. We found out that the Japanese market is willing to pay little more for a better quality product. All our efforts, therefore, are geared towards producing the best pineapple at minimum cost, emphasizing this quality image to the consumers.

To a large extent, the quality of the fruit is dictated by field practices which agricultural research is continuously working on. However, in addition to following the optimum field practices if we are to market field fresh pineapple in Japan, we still have to provide answers to questions such as the following:

1. What is the optimum degree of ripeness that we should harvest?
2. What kind of packaging material should we use to prevent bruising?
3. At what temperature should we ship the fruit to retard ripening and still avoid internal breakdown?
4. What kind of fungicide is suitable to prevent thievalopsis rot pronounced thee el ave opsis: A fungus invader) and is acceptable to the Japanese authorities?
5. Should we harvest from plant crop or ratoon crop?

6. How can we best sample an area to ensure harvest only of top grade fruit?

These and many other problems need to be solved at minimum cost if we are to market profitably the best fresh pineapple in Japan.

New product development work so far has been limited at Dolefil to development of pineapple-base fruit drinks using single strength pineapple juice and various fruit flavors, fruit oils, flavor enhancers and other ingredients. To date, six of these drinks carrying the Dole label are being sold in the Philippine market, namely, pineapple-orange, pineapple-strawberry, pineapple-apple, pineapple-grapefruit, pineapple-lemon and pineapple-grape drinks.

New product development, by all means, should not be confined to drink products alone. Other food products to work on could be barbecue sauces, Ketchups and marinades with pineapple juice concentrate as the base, candied pineapple core, spice or pickled pineapple tidbits for chunks, crushed pineaple relish for meats, fish and poultry, and other new products with possible consumer appeal.

Quite a lot of research work has been devoted to bromelain recovery from pineapple stumps in Dole Honolulu. In fact, commercial production of bromelain has already been started at Dole. There being a good market for this enzyme which is of important medicinal value, it might be worthwhile setting up a pilot plant in Dolefil for bromelain recovery from pineapple stumps which otherwise are just being burned or plowed into the field soil.

The fruit quality section inspects and grades pineapple fruit simples from the varous feld sources and from agri-research experiments. The processed data serve as guides for agri-research in making recommendations to the pineapple division regarding fertilization and other agricultural practices to improve the quality of the fruit.

In addition the fruit quality section takes recovery data on fruit resulting from experiments installed by agri-research and the plantation. These data are necessary for evaluation of experimental practices.

As in any manufacturing concern desiring the highest possible quality in its product, Dolefil maintains a quality control group. Its job is to insure the consistent production of satisfactory goods at levels and tolerances of quality acceptable to the buyers and to the industry. It mantains efficient standards of checks and depending on the number of units and the frequency of samplings made, evaluates the over-all quality of our products.

In addition, also prepares and recommends additions or revisions to existing specifications or established procedures. It tabulates information for the development of packing statistics. It tries and develops new test procedure that will make for better control. It is responsible for the proper recording and reporting of information related to quality and operations.

The data obtained by the quality control group form an invaluable basis for research on improvement of procedures, better fruit production in the field and possible development of new products and by-products.

Dole Philippines, Inc. has, at the plantation on Mindanao, a fully equipped chemical laboratory capable of doing analyses of water, soil, plant tissues, food products and agricultural chemicals. It has analyzed soil from every one of our fields and analyses leaf tissues from every growing field at least four times during the first nine months after planting. It might be called the backbone of our scientific endeavors. We also have reasonably good microscopic equipment and microbiological laboratory facilities. We can identify most fungi and nematodes which attack plants and products and determine how to control them.

We have to complete ginaca lines for assessing the quality of incoming fruits and fruit from field experiments. And we have a *product quality assurance laboratory.*

These *facilities* are *expensive.* They represent a *capital investment of nearly* ₱¼ *million.* To operate these facilities and do field research we *employ* an average of 75 *people* more than half of whom are graduates in science from Philippine universities. Many have advanced degrees in their specialties.

Dole Philippines, Inc. at the present *annually spends almost 1% (one) of* its *gross receipts for research* and expects that *more* will be spent *in the future* as we move into sophisticated research.

We believe that *these capital investments* and *annual expenditures* are *essential to success.* And we believe that our efforts can and will yield *benefits to agriculture* in general in the Philippines *as well as* to *our own industry.*

Research Complement

1. Dr. E. J. Anderson
   a) B.S. Agriculture
   b) Ph.D. in Plant Pathology
2. Cesar Alaban
   a) B.S. Agriculture & M.A. Agriculture
3. Thomas Escoro
   a) B.S. Agriculture
4. Dra. Aurora Calo
   a) B.S. Chemistry
   b) M.A. in Chemistry
   c) Ph.D. in Chemistry
4. Cynthia Alaban
   a) B.S. Chemical Engineering
6. Lourdes Ledesma
   a) B.S. Agriculture
7. Julia Pascual
   a) B.S. Home Technology
8. Teresita Aragon
   a) B.S. Chemical Engineering (Licensed)
9. Emilie Deocales
   a) B.S. Chemical Engineering working as Laboratory Analyst

INDUSTRIAL RESEARCH EFFORTS OF A. SORIANO Y CIA AND THE SAN MIGUEL CORPORATION*

A. Soriano y Cia is primarily a parent holding and management company. It manages seventeen corporate enterprises and holds substantial interests in more than seven other companies. The San Miguel Corporation, in itself an integrated complex of various industrial divisions, is the biggest among the corporate enterprises managed by A. Soriano y Cia.

The affiliated companies it manages are engaged in the production and distribution of goods for local use as well as for export and services. Among these are: beer; soft drinks; dairy products; glass, plastic and metal containers; cartons; metal closures; feeds; baker's yeast; logs; veneer; lumber; copper ore and concentrates; complete commercial fertilizers; industrial textiles; copper products; operation and maintenance of press, radio and TV communications media, tax service, stock transfer service and travel agency service. Products of other companies in which it or its affiliates have substantial equity participation include: silica, iron ores, instant coffee, canned milk, wire rope, flour, concrete products, ramie and synthetic textiles.

The diversity of these products requires different and often unrelated technologists and market systems. The organizational structure of A. Soriano y Cia including that of The San Miguel Corporation is, therefore, of the decentralized type. Each company or division is considered as a distinct business capable of sustaining itself profitably by producing goods or services for its customers. The respective managements of these affiliated companies and divisions have the added responsibility of maintaining a flexibility responsive to change. Within the limits of their capabilities, the jobs of researching and developing not only new products but also technologies in all the functional aspects of the business pertains to them. Thus, Research and Development efforts in our organizations are largely decentralized.

In areas not yet covered by any operating company or division and whenever assistance at the corporate level is required by the companies or divisions, R & D work is centralized. Centralized R & D complements the overall planning function at corporate level which among other objectives concerns itself with basic decisions as to the fields of business the corporation will enter and the dimensions of the company's commitments in these fields.

Some companies within the organization have related technologies and in certain cases, have common sources for their raw materials. Under these conditions, these companies have coordinated research programs. A typical example is the Bislig Bay Lumber Company and the Paper Industries Corporation of the Philippines. Both draw from the forest raw materials for their products. Their research work is geared to ensure the success of a long-range program and perpetuate the continuous productivity and utilization of

* L. P. Zialcita, Jr., Asst. Vice-President and Director of Research and Development, The San Miguel Corporation. Prepared for the Industrial Research Workshop, Baguio City, January 26 to February 1, 1969.

its forest concessions, and in keeping with the sound policies and programs of the government on forest conservation and its wise use. Among their research activities are:

a. Studies on the compositions of forest,
b. Growth and yield of timber stands by species, and,
c. Silvicultural practices, needed to improve stand-in composition and to produce maximum yields.

The introduction of new species suitable for long-fibered pulps and notably fast-growing ones for tree farms is currently emphasized. Coordination of the research program is expected to optimize the utilization of the forest concessions from which both affiliates have based their operations.

Financing of R & D projects in our organization forms part of our system of budgeting, viz., expense and capital budgets. We generally project our requirements for at least a 12-month period on the short-term and up to 5 years for the long-term planning. The division submits budgets which are studied, evaluated and approved, modified or disapproved by Management. Periodically, reports are submitted to Management on the progress of projects with sequential evaluations to determine continuance or discontinuance, as well as, explanations for variances from the budget. Occasionally, unexpected turn of events require special projects to be undertaken on a crash program. Under these conditions, our Management, cognizant of the expediencies of the situation, sets up special budgets with the necessary power granted to the individuals who may be assigned to administer the project. Generally, R & D Projects when completed provide Management with a sufficient basis to implement or not, depending on the ultimate profitability and financial estimates obtained.

At this point, allow me to cite some typical examples and experiences in our research efforts.

Some of our present ventures were brought about thru research investigations aimed at the profitable recovery of what used to be "waste products" of our older companies. The San Miguel Poultry and Livestock Feed Plant, which produces B-Meg feeds, is at present an outlet for the by-products of the Brewery, viz., Brewer's spent grains and yeast. The steady growth of our Feed Plant motivated us a few years back to develop a high yielding hybrid strain of corn. In close collaboration with the U.P. College of Agriculture which was the recipient of a SM research scholarship in this particular field, we found ourselves on the road to success and could foresee a modest contribution to our corn farmers in the form of a better seed. Unfortunately, our efforts in this agricultural endeavor were unexpectedly curtailed in 1963 by the rice and corn nationalization law.

In 1953, our staff of geologists and mining engineers, in the course of a program of exploration in various parts of the Philippines, discovered a copper mine in the island of Cebu. This is now the site of operations of the Atlas Consolidated Mining and Development Corporation which is considered as the largest copper mine in the Far East. Research studies undertaken in this area of investment shortly led to the establishment of the

Atlas Fertilizer Plant. In turn the technical staff, of this plant, successfully developed a novel process for the recovery of metallic copper powder and ammonium sulfate from copper wastes. This is now patented in the U.S.A., the Philippines and in fifteen other major countries. We are now past the pilot plant stage and expect the commercial application of this new process in the near future.

In a way, the Paper Industries Corporation of the Philippines (PICOP) was born out of a need to utilize the waste resulting from logging operations and the call for further integration of basic industries utilizing our natural resources.

In 1949, extensive studies were started on the production of pulp and paper from Philippine woods. The main technical drawback in the research studies was the difficulty of pulping composite varieties of Philippine woods (characteristic of our forests). This problem was successfully overcome by laboratory work done here and abroad. Pilot studies were next undertaken which clearly showed that paper manufacture from local materials was economically feasible. In 1954, International Paper Company joined A. Soriano y Cia and The San Miguel Corporation in still further studies of the proposed pulp and paper mill. This culminated in a mutual agreement to implement the project.

Recently, a contract with a Japanese group has been concluded for the purchase of a paper making plant worth U.S.$42 M. We foresee that in the near future our country will be self-sufficient in its needs for most types of paper requirements including a possibility of having an export market.

Another important feature of R & D work in our organization involves investigations that are aimed towards the replacement of imported raw materials with those locally available. This forms part of our industry studies wherein we systematically evaluate the feasibility of potential industrial ventures. Quite often we end up identifying and quantifying factors giving us more reasons why we should reject rather than implement possible new industrial ventures, under then existing conditions. Let me cite some instances:

a. The increasing cost of imported soft drink concentrates led us to undertake studies on the production of beverage bases from local citrus. We were able to produce a concentrate from Szinkum mandarin of the same or better taste, quality, and stability as the imported material. Pilot studies demonstrated economic feasibility as within reach, provided the agricultural base could meet the demand of ur operations. Unfortunately, local citrus production is now faltering due to still uncontrolled diseases. A survey revealed a growing disinterest on the part of growers. The project has been temporarily shelved until the agricultural sector can solve its pressing problems.

b. Years ago, we considered the feasibility of going into soybean milling to help stabilize the raw material position of our Feed Plant. Our studies then revealed certain deterrents that con-

vinced us not to engage in this manufacturing activity. We are now witnessing two pioneers in soybean milling beset with difficulties apparently due to the same factors which we had unearthed in our studies years ago.

c. In 1959, the Company initiated the Barley Project aimed at a possible production of barley malt for brewing from locally brown barley. Our estimates showed that substantial savings in costs could be effected if this project were to be successful, aside from the savings in foreign exchange. Trial plantings of selected varieties in the cool highlands of Bukidnon during five years were largely unsuccessful due to the prevailing humidity resulting in poor quality malting barley The grains were discolored due to weathering. Results of these experiments were read by a member of our delegation at the 11th Pacific Science Congress held in Tokyo in August 1966. It was our expectation to elicit interest from foreign workers in the same field and thus obtained other possible sources of more adaptable seeds. Some Japanese researchers voluntered to supply us with strains of more heat-tolerant varieties that they had worked on. We continued the experiments in Tagaytay. These new strains yielded good quantities of grain. Because of the high temperatures, however, we found that the grains are only good for our Feed Plant and not for our Brewery. Results further indicated the need for genetic work. This, we feel would be too time-consuming, costly and with little assurance of success for us to undertake. We, therefore, terminated our barley experiments last June 1968. A full report of our work has been submitted for publication in a scientific journal.

d. In contrast to the foregoing examples, we cite now the history of our Feldspar Beneficiation Plant. Years ago, our Glass Plant investigated the possibility of using local feldspar as source of alumina, which at that time was imported from California. A comprehensive survey of felspar deposits throughout the Philippines was then undertaken. Laboratory analyses of the deposits, however, indicated the impracticability of beneficiation of the deposits due to heavy contamination with undesirable components or the required uniformity was not obtainable. A review of the data on the sand deposits in Pampanga which previously was found unsatisfactory as source of silica, as well as, preliminary analysis showed possible beneficiation for feldspar.

After literature survey and extensive laboratory tests of different processing methods, magnetic separation was found to give the most satisfactory product. This method was further confirmed with the help and use of the more sophisticated

equipment of the Bureau of Mines, and later, on a pilot scale, by an American firm. Based on these tests, our engineers designed the beneficiation plant.

Since the plant was operational in 1957, no major problems were encountered and the plant performance has lived up to our expectations. Presently, this plant supplies all the requirements of the Glass Plants in Manila and Cebu, with savings in imported materials of about ₱1.2 M annually, a respectable figure when one considers that Feldspar is a minor constituent in the manufacture of glass.

Based on the foregoing typical samples of research efforts in our Organization, we now wish to point out certain features from our activities that we feel pertinent to the purpose of this workshop:

1. As in any type of human endeavor, a most important consideration is the manning of our research projects. In some cases, we were ready or fortunate to have available trained and experienced men who could undertake the investigations. In most cases, however, we had to train further young technical personnel for one to three years before we could have an assurance that they could be useful and productive in our research efforts. We strongly feel that much improvement in the quality of the graduates from technical schools who join our Organization every year is in order. We would like to hire a young man fresh from college with the following qualifications:

a. A basic knowledge of the sciences sufficient to make him think in terms of first principles.
b. A practical knowledge of economics sufficient to give him a "down to earth" approach to his work.
c. A good knowledge of English, spoken and written, to enable him to communicate his ideas and results of his work, as well as, to correctly interpret instructions from the other members of the Organization.

With regard to the first point, we feel that the government could help in upgrading the quality of technical training by endowing our technical schools facilities such as modern equipment and a good reference library. We have interviewed hundreds of young graduates many of whom had not even used a pH meter in College. Some areas of new management sciences, which had their origins from technical disciplines, should be incorporated in the under-graduate curriculum so that the new graduates, in joining private industry, will not undergo a long lag phase in catching up with modern management practices which most companies now have kept abreast with.

2. Everyone in this group is fully aware that in carrying out research investigations, one of the first steps would be to check the literature and the obtention of data and statistics from known sources. Much to our regret, our experience has been that we could not fully rely on the quality of the data and information available from government sources. As a result

of this, we have been constrained to undertake expensive field surveys during the data gathering phases of our work. This preliminary work would have been unnecessary and time could have been saved if the work of the government institutions concerned were to be improved considerably. We have been informed that the present condition of government statistics could be partly attributed to the indifference and lack of proper motivation of the entities or persons who are supposed to gather the basic data and information from the field. Perhaps a certain amount of attention could be focused in this area in order to remedy whatever causes this indifference towards excellence.

3. We, in private industry, are generally remiss in certain areas of the common field of science and technology that we are all in. And this is in the area of professional growth for our scientists and technologists. It is generally known and accepted that the government is in a better position to maintain contacts and liaison with agencies and institutions abroad that could be useful in furthering the professional and technical development of our scientists and technologists in private industry.

Presently, technical assistance programs such as the Colombo Plan, AID and other government-to-government grants, are being mainly channeled to government personnel. Because of inherent limitations of their office, these grantees go abroad, most often, without the necessary orientation of the local technical needs of industry. Moreover on their return and because of the same limitations, full use of their newly acquired knowledge is not realized. In general, they feel frustrated and ultimately join private industry still not fully effective.

Perhaps government could directly assist private industry in making available on a wider scale, such opportunities for contacts with technical and scientific institutions and agencies abroad. Private industry may not necessarily require funds from the government in this respect.

COCONUT INDUSTRY RESEARCH AN OVERVIEW

By MANUEL YLANAN

Perhaps it should be mentioned at the outset that although the term 'coconut industry" is bandied about and will be frequently mentioned in the course of our discussions, we should push out of our minds the picture of a monolithic, integrated, centrally controlled, national operation. In fact, the picture we must keep before us, in the course of our discussions, is a fractured picture — something like a jig-saw puzzle in process of being put together. Most participants are beginning to appreciate the beauty and the harmony that will emerge when all the pieces are locked into place. But as of now, many key pieces cannot as yet bring together the appropriate interfaces that will complement each other. Many pieces of the puzzle do not yet realize that they belong together. I believe it is important to remember this fractured picture as we discuss this industry-in-the-making, because it is the underlying fundamental condition that stands in the way of effective industry research. The details of this will emerge as we delve deeper into the subject.

DIMENSIONS OF THE "INDUSTRY"

Let us start with a little background. It would like to place the coconut industry in the perspective of the Philippine economy. From this discussion we would be able to appreciate the key role played by the coconut in the economy of the country.

Nearly two million hectares (about 4,942,000 acres) are planted to coconut. This represents 25% of the total land devoted to agriculture. Only rice and corn production utilize larger hectarages. The annual harvest is nearly nine billion nuts. This agricultural facet of the industry provides support for 2,600,000 people or about 20% of the country's total farm population. The major source of nuts is the island of Mindanao which produces almost half (47%) of the country's production. The Bicol, Eastern Visayas regions produce 29% of the total. And the Southern Tagalog region produces 15%.

Of these 9 billion nuts produced annually, 2% are consumed in the farms either as food nuts or home-made oil. The remaining 98% goes into commercial channels, with 6% ending up as dessicated coconut and the 92% going into copra. Exports of copra account for 55% and the 37% remaining in the country are crushed into oil. The equivalent of 22% of the nuts is exported as oil while the oil remaining in the country (representing 15% of the nuts) is manufactured into cooking oil, shortening, margarine, soap and filled milk, and other products, for sale in the Philippine market.

The export of coconut products – copra, oil, dessicated coconut, copra meal pellets and other coconut products produced a dollar revenue of about

215 million dollars into 1967. This represents 26% of the total export earnings of the country for that year. This background establishes the important role that the coconut plays in the Philippine economy and in the lives of a great number of Filipinos.

THE COCONUT AND THE WORLD

Another useful perspective is the place of the coconut in the fats and oils market of the world. This view outlines the competition that Philippine copra and coconut oil face when they leave the country as exports. It also serves to explode the myth that the Philippine monopoly of 40% of the world's copra production gives it the leverage needed to control world copra prices.

The world production of fats and oils is 35 million long tons (1967) and this is growing at the rate of 2.8% per year. While the Philippine copra production represents 40% of world copra production, it represents only 4% of world fats and oils production. Philippine coconut products face direct competition for many uses in international markets from other sources of fats and oils.

The list of competitors is long and impressive. Among the Edible Vegetable Oils are cottonseed, peanut, soybean, sunflower, rapeseed, sesame seed, safflower, olive and corn oils. The Palm Oils which include the coconut, of course, include palm kernel, palm, and babassu. Industrial Oils are linseed, castor, oiticica and tung. Marine Oils are whale, sperm whale and fish. Animal fats are competitors too, in the form of butter, lard, tallow and grease. In edible products such as margarine, which is the major European use for coconut oil, coconut oil can be substituted by many of the edible, palm, animal and marine oils. Similarly, the meal resulting from the oil extraction process of these fat sources are competitive to each other in their use as animal feed. For technical uses, mainly in the United States, coconut oil derivatives held entrenched positions in certain industries because of unique characteristics. The major uses of coconut oil derivatives are soaps and syntetics, textile chemical cosmetics and toiler products. There are also small volume uses for disinfectants, catalysts, synthetic perfumes, flavors and essences, dye-stuffs, pharmaceuticals, printing inks and other organic compounds. However, synthetic substitutes for these uses are coming out of research laboratories and going into commercial production. Usually the lower and more stable prices of these synthetic substitutes induce many users of coconut oil derivatives to switch.

This picture reveals that far from enjoying a secure monopoly position in world markets, Philippine coconut products must scramble aggressively for business in competition with other fats and oils. In such a market of easy substitution, price becomes an important consideration. Even in those uses where unique characteristics give coconut oil derivatives a monopoly position, sustained high prices, or unpredictable supply, or frequent wide swings in price, encourage manufacturers to develop synthetic substitutes in

self defense. These circumstances compel us to admit that price of our coconut products is not what we say it is but what the competitive situation in the world market indicates it should be based on the economic factors operating at that time.

THE AGRICULTURE OF THE COCONUT

Let us now talk a little about coconut production. Our impression when the words "coconut plantation" are mentioned is probably one of miles and miles of uniformly planted trees under a progressive central management utilizing scientific farming methods. The fact of the matter, however, is that outside of some large and progressive planters, the production of coconuts is undertaken mainly by a large number of unsophisticated planter with relatively small land holdings. There are about 440,000 planters and the average land area of a coconut farm is about 4½ hectares (about 11 acres). About 90% of the farms are less than 10 hectares in size. Although a few progressive planters actually "manage" their plantations and seek to maximize their returns through improved methods, the majority of planters are happy to accept passively whatever a bountiful mother nature provides.

It is at this plantation level that the major activity of the coconut industry takes place and where certain factors of cost and quality are introduced into the system which affect the ability of the copra and coconut oil produced to compete effectively in world markets. It is here at the farm level that the husk is separated from the shell and the meat from the shell. It is here where copra is made and where the husk and the shell become agricultural wastes or useful by products. The combined individual decisions of all these numerous planters to do or not to do certain things in their individual farms are critical to the industry as a whole.

Let me quote two statistics which perhaps succinctly express the condition we face in coconut production. In 1958, one average hectare produced about 6,000 nuts per year in the Philippines. In 1967, an average hectare produced only about 4,800 nuts per year. In 1960, one tree produced 45 nuts per year but in 1966 one average tree produced only 38 nuts in a year.

During this same ten-year period, 1958-1967, of decreasing productivity on the farms, scientists and technologists in our universities and government and private agencies were hard at work generating the new konwledge and techniques that could offset the deterioration in productivity and perhaps turn it around into spectacular growth. The agricultural aspect of research on the coconut was pursued in such institutions as the U.P. College of Agriculture in Los Baños, the Bureau of Plant Industry, the Philippine Coconut Administration the, Cadang-Cadang Research Foundation, the National Institute of Science and Technology and by individual faculty members and students in several universities.

The apparent availability of information and the concurrent deterioration in productivity seems to point to a chasm between the Filipinos devel-

oping new coconut knowledge and techniques, and the Filipinos who need this new knowledge and techniques. Certainly a key area for study is the reasons for this serious gap and the identification and development of ways to bridge it.

One consideration should perhaps be a questioning of the basic usefulness and practicability of the new knowledge generated. There is also the further consideration that if the objective is the widespread, voluntary, and effective use of this new knowledge, mere availability in scholarly journals is only a necessary first step. It needs to be followed by distribution, understanding, trial, and conviction. How to attain this desired ultimate objective could very well be a highly profitable subject of systematic inquiry.

THE MARKETING OF THE COCONUT

The next step on the coconut's way to final consumption is the collection and storage of the copra produced by many little farms and its transport to loading points for export, or to oil mills for crushing. The economic factors that affect all the participants in the coconut industry come to focus at this point. Also the apparent opposition of interests emphasized by this price bargaining situation can be seen at this point where copra changes ownership among the several Philippine participants in the industry.

The planter and the copra dealer negotiate to determine the price at which ownership of copra changes hands. Usually after this transactions is completed, the ordinary planter has no further interest in the copra he has produced. There is some feeling between the planter and the dealer that their interests are opposed and this feeling arises from the differences in point of view emphasized by the price negotiation that they undergo, unrelieved by any demonstration of the larger and more important common interest that bind them together. In turn, the copra dealer negotiates with copra exporters or oil millers. Here again the apparent conflict of interest is magnified, and again the copra dealer usually has no further interest in what happens to the copra he has sold. It is also safe to say that most copra and coconut oil exporters consider their interests to be in opposition to those of their foreign buyers and that they too have little interest in their oil or copra once they have effected delivery abroad. This view reveals the fissures that tend to divide the industry, that create the fractured picture we spoke of earlier.

Here too we see that the coconut is an important element in a world economic and technological system. Beyond the horizon of interest of the Philippine participants, the coconut links up with the fats and oils system of the world and the technologies of numerous industries. The costs and technical characteristics of the coconut product now transformed into margarine, or filled milk, or cattle feed, or shampoo, some chemical ingredient have a bearing on its competitiveness and useability in these complex and faraway markets. A little-known and even less understood chain of economic

and technical relationships links the planter of Camiguin island to the housewife of Frankfurt and the cosmetic chemist in New Jersey.

Perhaps more effective direction and control of coconut activity in the Philippines can be attained if these relationships are better known and understood. Certainly the communality of interest of the Philippine participants in this system needs to be emphasized and strengthened. Any industrial research effort must take into consideration the inescapable economic and technical factors inherent in these relationships. They can be obstacles to our hopes but also avenues of opportunity if understood and used intelligently.

THE COCONUT AS FOOD

Another useful approach is to view the coconut as a food source. But first, to pave the way for the discussion, permit me to cite some figures which some of you may already be familiar with. The Population Institute of the University of the Philippines has calculated that if all the factors affecting population today continue into the future, by the year 2000, which is only 30 years away, the Philippines will have 111 million mouths to feed. Today, in 1969, we only have 37 million mouths to feed and we have to struggle to do it.

Similarly, the world's population will grow from about 3.5 billion in 1969 to about 6.6 billion in the year 2000 and 60% of this population will be in Asia. The food requirements of this huge population are staggering to contemplate. This is especially a cause for concern when we consider that today large segments of the population are underfed and starvation actually exists in several countries.

Scientists and managers of organized scientific effort recognize this as a vital problem not only for individual countries but for the world as a whole and the problem of enlarging the world's food resources is being energetically attacked. There are many sources of food which are not now being utilized or are only being utilized incompletely or indirectly. These potentially rich food sources offer fruitful opportunities for systematic exploration and development. Among these is the coconut.

A gross view of the coconut and world food demand would see to indicate that, the Philippines, with a population and food problem of its own to contend with and being located in the midst of an equally growing and hungry Asia, is being offered a unique opportunity for leadership. Being the primary source of the coconut and the coconut already being considered an edible in some forms, we can perhaps conclude that the most efficient application of scarce Philippine scientific resources is to take the coconut all the way, developing it into a basic food for the Philippines, for Asia. This seems to be a very attractive prospect that calls for more detailed verification and investigation. Of course, more widespread technical uses of coconut derivatives are also possible, but the demand factor for these uses are not as predictable nor as critically urgent. And it would seem to be an inefficient application of scarce scientific resources to take a basically edible commodity

and transform it into no doubt technically useful but inedible forms, when there is a growing and serious need for food.

A SYSTEMATIC APPROACH

In summary, I would like to suggest that perhaps the idea of systems is a useful conceptual tool in approaching the problems and opportunities of the Philippine coconut.

For example, the social system environment of the coconut – understanding that the coconut is not just a simple economic activity but is a part of a system, of a culture, and a way of life. To effect a widespread and permanent change in the coconut requires consideration of the social system of which it is a part. This seems to call for an inter-disciplinary approach to the problem of getting new knowledge used, with the social scientist providing a contribution of equal importance to that of the physical scientist.

For example, the world system of fats and oils economics and technology –the appreciation that the cconut, large as it may loom in our minds and in our economy, is really only a part of this world system. To get the optimum pay-off at that end of the system where the ultimate consumer makes a "buy" or "no buy" decision, we must apply our scarce scientific and technical resources at this end of the system where the costs and the technical characteristics are built in. We must do this, with competent precision— concentrating on those projects that will have a significant effect on that ultimate buying decision. To do this effectively seems to call for a clear understanding of the system and constant up-dating of the facts. The technology and the economics of the fats and oils market are dynamic and developing. Not only a knowledge of what is now going on but a good idea of the trends into the future are critical to success. A development that looks promising and worthwhile this year could be useless when it enters the market next year because the technology or the economics has changed in the meantime. We must therefore, not only recognize the system as a system, but also learn to cope with it as a dynamic, living system.

My last example is concerned with the activity of research itself, the recognition that is a system – with an inner logic of its own, with objectives to be attained, with cause and effect relationships that can not be ignored, with a discipline imposed by standards of performance and deadlines that must be met. Certainly we must recognize that the scientific pursuit of new knowledge must be conducted within the frame-work of some agreed on systems. I'm sure we all appreciate that not all the projects we embark upon are successfully completed. When resources are scarce therefore, a very efficient system needs to be vigorously followed in order to optimize success. The management of research and development has come of age since World War II and much expertise and knowledge exists in this field. It is not facetious on my part, I believe, to suggest that before we try to develop new coconut knowledge and before we try to persuade the industry to use it, we should first take our own medicine and make profitable use of the new knowledge and techniques available to us in the field of research management.

RESEARCH AT VICTORIAS

By THOMAS R. MCHALE

Victorias Milling Company's interest in and commitment to formally organize research dates back to the early 1920's, when Dr. Carlos L. Locsin first joined the company as Sugar Chemist and Director of Research. Since that time–with only a wartime interruption–research activities have continued to play an important part in the corporation's life and development. The initial focus of the company's research efforts was agricultural. In this realm, Victorias was an early pioneer in the study of fertilizer responses of sugar cane under varying soil conditions. Victorias also worked closely with Philippine Gornment scientists in a variety of other fields including cane breeding, entomology and field mechanization. In the 1930's, as a result of quota restrictions on Philippine sugar in the United States markets, Victorias' research interest shifted to the industrial use of by-products and diversification alternatives for the economy. As an interesting footnote to Philippine industrial research history, it might be noted that Victorias produced alpha-cellulose from bagasse on a pilot plant basis in the mid-1930's and also produced the first rayon manufactured in the Philippines.

Since World War II, Victorias Milling Company research efforts have been concentrated in agriculture – although they have become broader in spectrum and more closely associated with industrial research. The necessity for adequate knowledge of local field conditions is still great. More and more, however, Victorias has learned that quantum increases in productivity requires access to research data, skills and information in many parts of the world.

As a background for discussion, a brief descriptive outline of our research activities might be helpful.

At the present time, Victorias Milling Company maintains a research department staff of eight professionals in the fields of soil chemistry, hydrology, plant physiology, entomology, and agronomy supported by a technical assistant group of approximately 20 and a field labor force of 60 full time employees. Also associated with the department are a statistical economist with a background in agriculture and a specialist in animal husbandry. The academic training of the professional staff includes two doctorates and three masters level degrees; most of the remaining staff have either have some graduate level training or special training in their own different fields. In addition, Victorias research department makes use of outside consultants in such specialized fields as cane breeding, micro-biology and hydrology from time to time.

Facilities maintained by the Research Department include a fully equipped soil laboratory, where both chemical and mechanical analysis can be carried out; a small micro-biological laboratory; a central experimental station with three additional field stations, a small green house, and a variety of other building utilized for laboratory experiments and specimen storage. The Re-

search Department also maintains two fully equipped weather stations and rain gauges at 17 field stations in various parts of the district. In addition to staff offices, a small reference library and a seminar room as well as a statistical computation office are maintained. In the field, the company normally has 30 to 40 hectares of experimental plantings; it also utilized commercial fields in outside farms totalling as much as several hundred hectares for large scale experiments.

The importance of research at Victorias can be gleaned from the fact that the Director of Research during the past 15 years has been either the President or Executive Vice-President of the company. The role of the Directors in both cases has been an active one and has included participation in both planning specific experiments and in the analysis of results; the preparation of technical papers; and the handling of much of the administrative responsibilities of the department.

Victorias Milling Company maintains a close relationship with the University of the Philippines, partcularly their College of Agriculture of Los Baños; with the Xavier University and with Siliman University. The company has provided all of these Philippine universities with financial support for research activity related to its own research program.

Victorias Milling Company gives strong encouragement to personnel advancement in their professional fields. Encouragement includes the financial support of staff members for studying both in the Philippines and abroad, as well as providing opportunities for the writing of research papers for publications and the attendance at national and international technical conferences. The department itself also has a research publication program which includes a bi-monthly experimental bulletin and occasional papers on specific problem areas of sugar cane agriculture.

In terms of overall budget, Victorias now is spending somewhat over one million pesos a year on research. Although it is difficult to make a division, we feel that over half of this total is spent on general research or data collection which should be undertaken by either the Government or the industry as a whole, rather than by an individual private corporation.

The problem of applied research – and this is Victorias' primary interest at the present time – starts with the isolation and formulation of significant questions relating to productivity that are susceptible to practical solutions. We know that sugarcane growth is related to many factors, including soil moisture, temperature, solar radiation, numerous major and minor nutrients, and a number of growth accelerators and retarders. We know that the sucrose content of cane differs from one variety to another and from one growth period to another. We know that certain varieties of sugarcane are susceptible to certain types of diseases or pest damage while others are not. We know that it is possible to control various diseases or insect pests of sugarcane by chemicals, by biological controls or by timing our planting or harvesting. We have learned that soil preparation, spacing of seed points, timing of fertilization and technique of fertilizaiton are all relevant to productivity. We also know that research can be very expensive; and it is very easy to accumulate vast quan-

tities of meaningless answers to meaningful questions or to follow line of inquiry that are not relevant to our real objective. The one thing that becomes more clear to us as time goes on is the absolute need to constantly review our research activity in light of both changing circumstances and changing knowledge available to us.

Victorias major research efforts are concentrated in a number specific fields including a continuation of work in the field of fertilizer responses. An increasing amount of information on relationships between plant growth and specific nutrients has been accumulating over the past four decades. Through experiments in hydrophonics – some of which we have carried out ourselves at Victorias – we recognize that it is possible to use soil as little more than a "positioning medium" for a plant like sugarcane in space. We have also learned that the essential nutritional needs of the sugarcane plant can usually be fed to the plant despite the type, or even the presence of soil. We also know that feeding can be done through the roots or through the leaves ot a plant, with the critical questions being the practicality of applications or trans-location speed. In looking at the sugarcane plant, our essential approach is to consider it somewhat like a factory. In oversimplified terms, the input of nitrogen increases the size of the factory – in this case, the vegetative stalk– for storing sugar; the input of phosphate provides easier access to the factory for raw materials – moisture and nutrients – by providing a more highly developed root and leaf systems; and potash serves to increase factory output– in this case, sucrose – by making the other nutrients work more effectively as converters.

From a practical point of view, sugarcane, obviously, cannot be grown hydrophonically on a commercial scale. It is, therefore, necessary to have a full awareness of the soil types and rainfall patterns of the areas in which sugarcane is to be grown commercially in order to provide or supplement the necessary nutrients that might be unavailable from the soil.

In Victorias, with its wide ranging topography and micro-climatic variations, this is a formidable tasks. Nevertheless, a comprehensive soil classification and mapping project was carried out in the early 1950's covering the entire district. To supplement this data, we maintain a program of continuous analysis of cane fields soils, and do leaf analysis of cane growing in the soils, so that we can provide a nutrient balance sheet for planning economically optimum fertilization recommendations.

To complement our information on soil types, Victorias Milling Company prepared an isohyetal map of the district based on a collection and analysis of rainfall records over 17 years. With the awareness of rainfall patterns indicated by our isohydral maps, moisture zones were classified in the same manner as soils. On the basis of both classifications, general recommendations regarding varieties to be planted, time of planting and cultural practices can be made. We are still a far distance from more comprehensive information we need and desire in this field; but have made a start.

In the field of climatology, Victorias has had the active cooperation of the Philippine Weather Bureau. However, our research efforts would be enhanced if more up-to-date and comprehensive data on solar radiation, rain-

fall patterns land surface and sub-soil temperatures were available. Victorias would also like to see more basic research in the Philippines on the weather, particularly on long term predictions. We would also like to see more studies on the relationship between plant growth and the natural factors of sunshine, temperature variations, and available moisture. In other words, Victorias Milling Company would like to concentrate its efforts on problems of immediate operational relevance rather than on basic questions that are common to the whole country or at least to the industry.

Perhaps the most important and most spectacular research activity now going on at Victorias is in the realm of varietal breeding. Sugarcane breeding has been carried on in the Philippines over the past forty years, but always on a limited scale with the number of new varietal seedlings produced usually totalled in the tenths of thousands. Victorias Milling Company itself had a modest breeding program in the period before and immediately following the war, but terminated it when the national government undertook the responsibility through the Philippine Sugar Institute in 1950's. In 1967, however, Dr. Albert Mangelsdorf, one of the world's foremost sugarcane genetecists and our consultant on agricultural research, pointed out the absolute necessity of expanding sugarcane breeding programs in the Philippines in the future. The facts of the situation were clear in almost all sugar producing districts including Victorias. Yields per unit surface area were on a downward sloping trend. In many areas, no significant new varieties had been developed in decades. Increasingly, the impact of a wide range of pathogenetic and insect enemies of sugarcane were running ahead of the chemical control agents that were becoming more widely available in the industry.

On the basis of a recommendation by Dr. Mangelsdorf, Victorias established a crash program geared to the production of a large variety of new seedlings during the 1967-68 time period. Before such a program could be successful, however, it was necessary to organize and train people in various breeding techniques. Dr. Mangelsdorf undertook a large part of the training at Victorias; this was supplemented by sending some of our research staff to Australia and United States to observe breeding operations in other areas. (It is interesting to note that we were forced to utilize individuals trained in other fields to handle our breeding program. However, we have found that intelligent individuals with a sound scientific background, if properly motivated and supported, can move quickly into new fields.)

Before large scale breeding is possible, it is necessary to develop a medium which will enable cut cane to retain its viability over a period of three weeks or more. Only by this means is it possible to ripen large number of stalks for crossing at a central collecting station. Although both the University of the Philippines College of Agriculture and the Philippine Sugar Institute were running breeding programs at that time, they were not geared to the size of operation we felt necessary and had no experience in the type of mass production techniques which we were trying to develop.

Fortunately, our crash program experiments led to the development of a chemical solution which was highly successful in keeping our cane viable for the necessary ripening and crossing period; our germination procedure also

proved successful and we managed to germinate over one million new varietal seedlings less than eight months after we decided to go into the new program. Drawing on outside consultant skills and young, research oriented personnel, with basic scientific training in a variety of fields, we probably succeeded in breeding more new varieties of sugarcane in a one year period than had been bred in the entire history of the Philippines up to that time.

During the first year, 416,944 of these varietal seedlings were selected and field planted; from this population, 8,974 were selected out in a secondary stage; tertiary selection will take place later this year. In the past, it has been assumed that 10 years elapse before a new commercial variety can be developed. With more advanced statistical techniques and with regional testing stations, Victorias new hopes to cut this down to five or six years.

Actual breeding is only one part of the program. To insure that we can secure the characteristics we are looking for in a new cane varieties, it is necessary to have a wider variety of germplasm sources as possible. Over the years, Victorias had maintained a varietal garden for this purpose, but its size was limited. With recent importation, however, we have increased our basic breeding collection to 321 outstanding parental varieties, and in cooperation with the University of the Philippines College of Agriculture, we hope to steadily increase this germplasm bank for future breeding work. In addition to the conventional "noble" cane varieties and the most productive commercial cane from all over the world, we are now seeking out specific qualities in parental material in various parts of the Philippines, including the Ifugao mountain areas.

Another major research project at Victorias Milling Company at present is a comprehensive study of alternative cropping systems for the production of sugarcane. Essentially, we are trying to establish the economic feasibility of deeper plowing, wider planting and the use of fewer seed pieces under a variety of soil moisture and solar radiation conditions. Conventionally, the Philippine Sugar Industry has operated on a six to eight inch plow depth tillage system and has relied mainly on low horsepower rubber-tired tractors for field operations. Our experiments involve comparison of this conventional system involving tillage depths going up to 30 inches; a complete change in the prime-moving equipment utilized is involved. In this project, we have planned, planted, harvested and analyzed 47 alternative cropping concepts experiments out of 54 large scale field experiment that were distributed throughout Victorias Milling Company's six major soil areas and four micro-climatic conditions.

We are now in the third year of this experiment and have firmly established the yield advantages of deeper plowing under conditions in most of our district. The yield advantages of deeper plowing over shallow plowing appears to be most pronounced in those areas affected by long dry period since deeper plowing encourages the development of vigorous and strongly branched roots and permits the developments of a deeper root zone which provides a larger reservoir from which the plant can draw moisture and other nutrients during the periods of drought.

Another nteresting area at Victorias research is in the field of chemical ripeners. The problem of poor juice quality in sugarcane in mose sugar producing country during periods of heavy rains is widely recognized. The reason for this poor juice quality is related to the continuing vegetive growth under conditions of excess soil moisture. Our research department is seeking a growth regulant or ripening chemical that will limit vegetive growth at the same time it encourages production of sucrose in the plant. Four growth regulant chemicals which have been found promising in other parts of the world are now being tested in Victorias with encouraging results. Larger scale experiments are currently underway to test these ripeners and application techniques on a commercial basis. An effective ripening chemical or growth regulant, if possible and available at economic cost, would represent a significant breakthrough in the sugar industry since it would lessen the tonnage of cane that has to be harvested and transported to provide a given amount of sugar; it would make many canes more economically attractive to grow, and lengthen the harvesting period in many areas.

In addition to the research mentioned, Victorias is also conducting experiments on biological control of stalk-borers using a native parasite; experimenting with sugarcane transplanting techniques, conducting inter-croppings and rotation trails; continuing experiments with rain making; and running a variety of preliminary or skirmish experiments in several other fields.

Although not a major undertaking as yet, our preliminary experiment relating to transplanting of sugar cane and crop rotation patterns are, potentially, extremely important. From a number of experiments we have conducted in the past, we have found that the growth of sugarcane in fumigated soil is far more vigorous and produces far more sugar than under normal field soil conditions. The hypothesis that we have established from this fact is that sugarcane growth is significantly affected by a soil pathogen complex and that large increase in yield could be gained if we could destroy this complex of soil pathogens. To fumigate the soil on a commercial soil however, does not seem economically feasible at this time. As an alternative, however, we are experimenting with a crop rotation program that will rotate soybeans with sugarcane. The assumption is the soybean, being genetically and physiologically far different from sugarcane, will not provide an adequate host for the soil pathogens which are presently retarding the yield of our cane. However, from an economic point of view, it is extremely costly to take land out of cane production for the several months that would be necessary to grow soybeans.

As an experimental approach, we are now nursery planting sugarcane in single-eye cuttings in a sterile soil medium in extremely dense stands that occupy only one to two percent of the normal space requirements in a commercial field. At the same time, we are planting commercial cane fields with soybeans. After soybeans are harvested, we will transplant the sugarcane from dense nursery beds into the commercial field at normal spacings that are over fifty times greater than nursery spacing. By planting the legume before transplanting, the nursery grown cane seedling we hope

to break up the symbiotic relationship between the sugarcane and the soil pathoging complex, thus increasing our sugar yields. At the same time, we will have harvested a crop of soybeans. The growing of the cane in the sterile soil nursery and the subsequent transplanting minimize production growth time losses so that little is lost in terms of the cane growth. If our hypothesis is correct, the rotation with soybeans will disturb the soil pathogen complex and lessen if not eliminate the negative influence on our cane growth cycle.

Looking at the problems of research in the Philippines in point of our own organizational history and experience, provides us with an opportunity to draw a number of tentative conclusion as well as to make a number of suggestions for research activities in the Philippines. Included will be the following:

(1) Research efforts are absolutely essential if agriculture productivity is to be maintained and increased in the Philippines. At the same time the number of promising avenues of research in agriculture are almost unlimited.

(2) Effective research in the Philippines requires good organization and strong support from the top. To shunt research away from sources of power and financial support invariably leads to completely ineffective research activities. The government, particularly industries like the sugar industry, and individual firms, must recognize the incentive reward mechanisms of research activities as well as the cost of both successful research activities and failure of such activities.

(3) To be most effective, Philippine research in agriculture must be actively integrated into a world vision of what is being done. The potential contribution of international research is particularly important in agriculture.

(4) The selection of research personnel is of critical importance in the Philippines where the environment tends not to differentiate between ritualistic education and attainments and functional education and skill. Nevertheless, the number of highly productive research personnel available in the Philippines is probably relatively greater in almost any developing country in the world.

(5) Both the quantity and quality of research output can be kept on a high level by demanding individual professional performances meet world standards rather than any local standards.

(6) Our recent experience in having a hydrologist and an entomologist organize one of the major cane breeding program in the world suggests the possibility of utilizing available skills along a wider spectrum of research activities.

(7) The contribution of government research agencies in the Philippines is difficult to assess. In general, however, we

tend to believe government gets less out of their research peso than most of the other research organizations. Nevertheless, the need for basic research being done by the government and its agencies is tremendously great and we would look forward to the time on much of the basic work we are doing now would be undertaken by either government or industry research agency.

RESEARCH EFFORTS OF THE NASIPIT LUMBER COMPANY, INC. AND ITS AFFILIATES

By FLORENCIO TAMESIS

INTRODUCTION

The Nasipit Lumber Company, Inc., was organized to engage in lumbering operation with the objective of developing its concession on a progressive management plan. The idea is to keep the forest perpetually productive and to take advantage of the utility or conversion of multiple forest products found in its holdings. After a year or so of its operation, the Management realized that a big bulk of wood waste was either thrown away or burned or left to rot in the forest. To utilize this waste was its main concern. Back in 1949, the concept to utilize slabs, edgings, trimimngs, etc., was seriously considered. This resulted in the expansion of operation and the establishment of a new factory for hardboard whose products are now known in the market as *Lawanit* and *Lawanex*. In the process of expanding the lumbering operations more wastes were produced. This called for more intensive studies to utilize everything including sawdust into any new products that could be developed for local consumption as well as for export.

INDUSTRIAL RESEARCH

Starting from meager technical data on the adaptability of woods found in its forest holdings, the Company had to organize its own research division —established a laboratory with equipment sufficient to carry on applied and developmental research and supported with a well-equipped technical library. The industrial research on wood utilization began. In 1957, when the Philippine Wallboard Corporation, an affiliate of the Nasipit Lumber Company, Inc., started operation, applied research was undertaken with the aim of improving the quality and control of the fiberboard product within worldwide standards or better. Since its establishment, the search for better products has continued. As in any new pioneering industry, the first few months of its operation is always devoted to the task of familiarizing the personnel with the nature, features, and idiosyncracies of the factory. Thereafter they proceeded to develop a simple but effective system of product and manufacturing process control. The early phases of quality control research had been centered on knowing more about the product and the raw materials that go into its manufacture, analyzing the processes, and improving on them, and later on finding new materials as substitutes for imported and/or expensive ones.

The aim of hardboard quality control may be summarized as dealing with the following properties of a hardboard: (1) the hardboard must be flat, smooth, of uniform color and free from surface blemish; (2) its variation in thickness and dimension must be within the closest possible toler-

ance; (3) must have adequate strength; (4) that the product should saw easily and be capable of being planed and machined to smooth edge; and (5) that its dimensional change due to variation in relative humidity of the environment must be as small as possible.

The freeness of the pulp from the defibrators and raffinators as well as the pH of the pulp from the headbox are tested every two hours. The amount of paraffin in the solution is likewise checked every hour. Tests are conducted to verify the modulus of rupture and thickness of the boards after pressing, and after passing through the humidifying chambers. The objectionable feature of the board has been the constant problem of manufacturers, but after some experiments, our factory was able to produce boards with greatly-improved resistance to movement as a result of treatment with adequate additives which had the effect of minimizing the moving tendency of the boards due to humidity changes. And in the case of oil-tempered boards, the problem of delamination and brittleness had also been eliminated through a stricter control of chemical mixture and treatment.

Chemical additives from local and foreign sources are usually tested for compatibility and for effects in hardboards under varying conditions and also to determine the optimum condition of treatment for raw materials and product. Studies have been continuously made on the results of some process and product research development to which many of the improvements in the production and quality of Lawanit today could be traced.

Studies of Philippine Woods for Hardboard Manufacture

From experiments conducted, the following indigenous and exotic species were found to be acceptable for hardboard manufacture:

almaciga (*Agathis philippinensis*)
makaasim (*Eugenia* spp.)
doldo or South American kapok, and kupang (*Parkia javanica*)
moluccan sau (*Albizzia falcata*)
anchoan dilau (*Cassia spectabilis*)
bagras (*Eucalyptus deglupta*)
Eucalyptus robusta
Benguet *Pine* (*Pinus insularis*)
apylon (*Podocarpus* spp.)
white oak (Quercus spp.)
African tulip (*Spathodea campanulata*)

Although their water content resistance is below the standard, acacia, cassava, coconut trunks and hinlaumo could also be made into acceptable grade hardboards. Coconut coir and stems could likewise be made into satisfactory grade hardboards if only their content of fines were kept down to 10-15%. Later studies also showed that the following wood species were also found satisfactory for hardboard making:

anabiong (*Trema orientalis*)
apitong (Dipterocarpus' spp.)
gubas (*Endospermum peltatum*)

bagtikan (*Parashorea plicate*)
gubas (*Endospermum peltatum*)
kaatoan bangkal (*Anthocephalus chinensis*)
red lauan (*Shorea negrosensis*)
white Lauan (*Pentacme contorta*)
makaasim (*Syzygium nitidum*)
malapapaya (*Polyscias nodosa*)
mayapis (*Shorea sqyamata*)
tangile (*Shorea polysperma*)
tiaong (*Shorea agsabcensis*)
tulo (*Alphitonia philippinensis*)

Researches of Insulation Board Materials.

Blending pulp of the following wood species was experimented on and found to be acceptable for insulating boards:

moluccan sau (*Albizzia falcatta*)
lumbang (*Aleurites moluccana*)
hinlaumo (*Mallotus recinoides*)
anabiong (*Trema orientalis*)
tulo (*Alphitonia philippinensis*)
white lauan (*Shorea negrosensis*)

Researches on Paper-making

By using the semi-chemical process, tests showed that moluccan sau could be used in the production of paper for corrugating medium of corrugated containers to produce acceptable grade paper. Experiments indicate that a possible source of long-fibered pulp would be wild bananas which grow in abundance in the logging areas especially during the first few years after logging. It was found that only 3-5% by weight of this material are available fibers.

Lumbang Nuts and Oil Extraction

Some research efforts of the Company are being directed towards the utilization of lumbang oil to temper hardboard and the development of a protein adhesive and plastic from lumbang meal. Studies are also being made on the possibility of producing sauce (Patis) and monosodium glutamate from lumbang meal. The utilization of lumbang shell as substitute for wood flour (a filler for dynamite and glue) and the preparation of activated charcoal are also under study.

Heretotore, the Company had been using tung oil to temper hardboard with lumbang oil as merely an extender or diluent. Recently, through continuing research, the Company has found an almost 100% lumbang oil formula to temper hardboard. Besides tempering hard board, lumbang oil is also used as a vehicle for paints and varnish. However, a lot more possibilities of the lumbang oil and meal need further studies.

The present process of extracting oil from lumbang nuts is to pre-heat the nuts to 100 – 120°C in order to crack the shells, separate the meat by flotation,

and then mechanically extract the oil. Recovery of oil is poor. Solvent process offers the best method of oil extraction, only it requires more investment in machinery.

Kiln-Drying

Ways and means are being devised to appreciably shorten the period of drying of the different wood species handled in the Company's dry kilns. Among them are studies on pre-steaming of freshly sawn lumber before the drying process is made. Results indicate that steaming reduces the drying time to as much as one-third the usual period which in case of one inch boards may be 5-7 days. This process was initially tried on apitong, and with favorable results thus obtained, it is now being used practically on all wood species. Besides pre-steaming, studies are also being made on air-drying of lumber. Studies also indicate that cost of production in the dry kilns will be materially reduced to 50%.

Wood Preservation

In the field of wood preservation, studies have been conducted to effectively use Boron and Boliden K-33, a copper-chromium-arsenic compound, in treating lumber and other wood products to the satisfaction of our consumers. Studies are also being conducted to enable deeper penetration of preservatives so that the life span of the treated products may be further lengthened. We can now pressure treat freshly-sawn lumber. A study on the leaching-put of wood preservative is likewise being undertaken to confirm the manufacturers' guarantee that 98% of the chemicals stay in the wood with only about 2% leachable. In a graveyard test currently being conducted to determine the durability of treated lumber by exposing wood samples to the elements, termites, marine-borers, and other destructive agencies, the samples are still intact after 3 years.

Presently, the Company is carrying a research on a suitable chemical to act as a fire retardant when injected into the wood. Results of experiments with FR-28, a fire retardant chemical, indicate that the flame-spread of the treated wood over its surface is considerably reduced. Although the chemical does not make the wood fire-proof, at least it delays or reduces its burning. The identification of fire retardant and the wood species is a material guide to actually see the effect of treatment.

Flush Door and Parquet Materials

In addition to gubas (*Endospermum peltatum*), such species as apitong (*Dipterocarpus* spp.) malaikmo (*Celtist philippinensis*), lanipan (*Terminalia copelandii*), white lauan (*Pentacme contorta*) and white nato (*Pouteria macrantha*), have been found to be excellent materials in the manufacture of curls for placarol flush doors.

Formerly, the Company's production of flush doors was 116-120 panels a day. This record has been increased by 300% through reduction of delays in the different manufacturing processes. Recently, the Company has introduced

in the market the placarol panels, grooved style, which are just placarol doors but with grooves at the sides to enable the arrangement of several pieces into one seemingly unbroken wall to serve as inner walls or partitions. This innovation has been reported by building contractors as having reduced installation costs of walls and partitions by 300%. Moreover, new designs for table tops using tilewood are also being created to capture the interest of the consuming public.

Barks and Tannings

Extensive research is being done by the Company on barks of trees. Heretofore, barks which may comprise about 8% of the total volume of a tree had not been fully utilized and invariably left to waste in the logging areas and the sawmill. The use of tree bark for fuel is a utilization in its low-grade form. Hence, the Company decided to conduct experiments for a fuller utilization of barks.

Tests showed that barks could be good materials for hardboard manufacture. It was also found out that barks contain sizeable amounts of natural resins which, when extracted and mixed with lumbang oil, could be used for tempering hardboard in lieu of the more expensive tung oil.

Studies are also being conducted to extract tanning from barks to be possibly used as adhesive in plywood manufacturing.

Personnel Training and Manpower Development

As part of the Company's personnel training and development program, a continuing year-round series of group discussions and open forums have been scheduled. Topics, usually on leadership and management, are assigned to resource speakers for discussion at designated dates. Yet in its inceptive stages, the matter is only being experimented with among supervisors at Nasipit but it is planned to eventually extend the project to employees in the logging camps.

To upgrade the quality of its working force, the Company has opened a school for forest workers, believed to be the only one of its kind in the country today. Deserving children of employees of the Company who are at least high school graduates are admitted free to be trained as forest technicians. The training lasts for only a year but the students, during their stay, are oriented and trained in the various aspects of woods and industrial operations. After their graduation, they are given certificates of completion in addition to preference for employment with the Company. Now on its third year of operation, the school has already turned out a total of 30 trained technicians, most of whom have already been absorbed in the Company's working force.

The educational training program adopted by the Company is carried out by giving scholarships to deserving employees who have shown dedication to their work and interest in furthering their studies in forestry and allied subjects, and also regularly sending Company personnel for training abroad to keep up with the modern trends of industrial development.

FOREST DEVELOPMENT RESEARCH

In 1961 the Company started developing a 38-hectare lot as an arboretum where native as well as exotic species were trial-planted. To date there have been tried already 11 native species (acacia, apitong, bagtikan, Benguet pine, carpod, ilang-ilang, kupang, lañgil, Mindoro pine, molave, and narra) and 9 exotic species (African tulip, Palestine bangkal, *Pindus densiflora, Pinus thumbergii, Shorea gysbertsiana,* Spanish cedar, South American mahogany, teak, and yemane). Periodic measurements taken and observations noted about the trees are recorded in index cards for possible ready reference to the forest development program adopted. It is also planned that the arboretum will be developed as a seed garden where various trees with desirable qualities will be propagated to furnish seed and seedlings stock for the reforestation program.

The Company realizes the fact that adequate raw materials for its conversion plants must be insured. Toward this objective, the Company has initiated a retorestation program purposely to augment whatever available material that can be utilized from the forest concession. To raise the necessary planting stock for reforesting portions of the logged-over areas, a forest nursery has been developed in an almost flat area about 6 kms. southwest of the logging camp at Tuñgao, Butuan City, between one of the old main-roads and a creek. At present there are a green house, a potting and soil-preparation shed, 50 open seed and transplant beds and 10 storage sheds, the last capable of storage sheds, the last capable of storing about 718,500 potted seedlings at one time. Since its establishment in 1961, this forest nursery has already raised about 5 million seedlings of various species at a cost of almost a quarter of a million pesos.

Trial Plantings of Fast-Growing Species

Some species planted in the arboretum that are believed to be of possible use in any of the factories of the Company and its affiliates established at Nasipit, Agusan, are also trial-planted elsewhere in the concession. The most important of these and the most extensively planted is moluccan sau (**Albizzia falcata**) of the legume family because of the wood's suitability for pulp and paper manufacture its importance as a soil conditioner due to nitrogen-fixing bacteria in the root nodules, fast-growing characteristics and prolific seed-bearing qualities. In fact, the Company has on record some 2,640 hectares already planted to this tree mostly on accessible areas along the roads, spar tree areas, and abandoned kaiñgins. Seeds were obtained from Impalutao, Bukidnon, and later on from the first plantings. Analysis of the data from 101 growth plots established from mid-1967 to mid-1968 all over the trial areas indicate that the 1965 plantations grow at the rate of 46.08 cu.m. per hectare per year, the 1964 plantings 38.65 cu.m., the 1963 plantings 32.28 cu.m., the 1962 plantings 29.25 cu.m., and the 1961 plantings 23.64 cu.m. per hectare per year; that the annual growth appreciably decreases after the 6th year after planting, indicating the desirability of either thinning or harvesting; that the periodic annual mortality is 12.6% for the 1961 plantings 14.6% for the 1962, 16.9% for the 1963, 20.8% for the 1964 and 27.4% for the 1965 plant-

ings or a general average of 17%; and that volunteer trees may invade the plantations and may compose as much as 85% of the number of trees and 67% of the standing volume. A volume-regeneration study of the species established all over the trial areas in mid-1968 indicated that when a plantation is clear-cut when the trees are already bearing fruit there will be enough sprouts or seedlings or both coming up to reproduce the area satisfactorily, and that estimates of the volume of the standing timber thereat may be in error by as much as 42%.

Kaatoan bangkal (**Antocephalus chinensis**) was test-planted starting 1963 chiefly because of the wood's value as veneer wood and pulp material. Seeds were obtained from the Forestry Campus at College, Laguna, and the seedlings were raised at the Company's forest nursery in Tungao, Butuan City. Partial reports from 7 plots established in the 28-hectare trial areas indicate that a tree farmer can obtain 165 cu.m. per hectare at the third year, 274 cu.m. per hectare at the the 4th year, and 290 cu.m. per hectare at the 5th year; that mortality rate of plantation when originally spaced at 2 m. x 3 m. is about 6.9% in the 2nd year, 4.7% in the 3rd year, 3.5% in the 4th year, and 3.2% in the 5th year; and that the trees are periodically attacked during summer by leaf-miners and defoliators.

Bagras (**Eucalyptus deglupta**), the only native eucalypt in the Philippines, has been tried in areas mostly above river banks and higher slopes of hills. Seeds were obtained from large trees along the Baliguihan River at Gingoog, Misamis Oriental. A 6-year old sample area containing 129 tree was found to have 13.5 cm. average diameter at breast height (d.b.h.), 8.6 m. average merchantable height, 12.7 m. average total height, and 0.12 cu. m. volume per tree. At the old planting distance of 2 m. x 2 m., this would mean a probable growth during the 6-year period of about 50.00 cu. m.a. hectare per year.

Nursery-raised seedlings from yemane (Gmelina arborea) seeds received from Indonesia in the later part of 1961 were test-planted at 2 m. x 3 m. along a feeder road near the logging camp at Tuñgao. Some 66 trees measured a year and 2 months after planting had an average diameter of 3.15 cms. and an average height of 2.7 meters. Eleven months thereafter the average diameter was 8.4 cms. and the average height was 5.9 meters with a mortality rate of about 6% per year. Six years and four months after planting, the average diameter was 15.2 cms., average height was 12.7 m. and the average volume per tree was 1.34 cu. m., mortality rate was 0.7% per year. These indicate that in a hectare of yemane planted at 2 m. x 3 m. there would be in 4 ¼ years about 1,396 trees with a corresponding volume of 92.50 cu.m. averaging 13 meters in height.

In June 1965 an area, where the original vegetation was destroyed by a cable of a diesel donkey yarder, was test-planted to paper mulberry (**Broussonetia papyrifera**). Seeds were secured from trees at the Forestry Campus at College, Laguna; germinated at the Company's forest nursery in Tuñgao; and test-planted at 2 m. x 2 m. A 0.05-hectare plot established therein in August, 1967 contained 85 trees with 9.3 cms. average diameter, 11.6 m. average height, and 0.05 cu. m. average volume per tree; mortality was 13% annually. This

indicates a growth of about 42.00 cu.m. per hectare per year for the first 2 years.

Teak (**Tectona grandis**) was one of the species first tried for roadside planting. Seeds were obtained from trees at the Forestry Campus at College, Laguna; germinated at the Company's forest nursery in Tuñgao, and the seedlings balled preparatory to planting. The development of some plots established n the trial areas are as follows: 5.5-year old plot of 0.25-hectare containing 174 trees had 1.2 cms. average diameter, 1.1 m. average height, and 0.001 cu. m. average volume per tree; a 9-year old plot of 40 trees had 1.2 cm. average diameter, 1.2 m. average height, and 0.01 cu. m. average volume per tree; a 10-year old plot of 0.231 hectare containing 113 trees had 1.8 cm. average diameter, 1.4 m. average height, and 0.01 cu. m. average volume per tree; and an 11-year old area containing 30 trees had 2.3 cm. average diameter, 1.3 m. average height and 0.01 cu. m. average volume per tree. These indicate that a hectare planted to teak would yield in 10 years time about 63.58 cu. m. In plantations free of underbrush, thick regeneration would spring up both from fallen seeds and sprouts of exposed roots.

Black wattle (**Acacia julibrissin**) was also test-planted in August, 1962, along a feeder road near the logging camp at Tuñgao. Seeds were obtained from mature trees at Impalutao, Bukidnon. Two 0.03-hectare plots established in the test-area in March of 1968 indicated that a 5.6-year old plantation would be 15.1 cm. in diameter, 14.1 m. tall and yield about 68.00 cu. m. a hectare; mortality would be about 13.3% per year.

Other species that have been tried but with silvicultural data still incomplete are Benguet and Mindoro pines, South American mahogany, African tulip, **Shorea gysbertsiana, Dryobalanops** sp., **Araucaria cunninghamii** and several eucalypts from other countries.

Plantations

There are about 2,640 hectares now planted to Albizzia falcata most of which are along the roads. The present rate of planting is 600 – 1,000 hectares a year at a spacing distance of 2 m. x 3 m. A good portion of the planting areas are devoted to native and exotic pines as a prospective source of long-fibered pulp.

In 1964 about 130 hectares on top of a plateau located about 12 kms. northwest of the logging camp were cleared of vegetation except the gubas and dipterocarps and planted to moluccan sau. The plantation now is a mixture of both species with the largest gubas 38.6 cm. d.b.h. and 30.0 m. tall and the largest moluccan sau 26.8 cm. d.b.h. and 25.0 m. tall. Data from plots established therein indicate that there are 162 trees with a corresponding volume of 162.65 cu. m. per hectare of which Moluccan sau is 59.6% of the number of trees but only 21.2 of the volume, gubas is 37.7% of the number of trees but 51.8% of the volume, dipterocarps is 1.8% of the number of trees but 25.8% of the volume and volunteer pulp-wood species like anabiong. tulo and ilang-ilang is 0.9% of the number of trees and 0.7% of the standing volume.

About 500 hectares of non-selectively logged areas of very favorable topography situated 17 kms. from the logging camp along one of the main roads where timber smuggling is rampant are being cleared and planted to several species like moluccan sau, kaaotan bangkal, narra, yemane, teak, South American mahogany, molave, African tulip, Benguet and Mindoro pine, and other exotic pines. This test plantation will provide comparison between the growth characteristics of the various species planted under similar conditions.

Inventory-Growth Studies

A growth study utilizing a standard design was initiated in July, 1966, to obtain accurate data on the standing timber in the logged-over areas particularly on the composition, structure, mortality, growth, and response to logging. The work plan provided that there would be 149 plots to be established in the non-selectively logged areas and 141 plots in the selectively-logged. To date about 90.6% of the former and 82.9% of the latter are already established at a cost of about ₱53,000. These plots will provide the bulk of the technical data necessary for the revision of the Company's timber management plan.

Cooperative Silvicultural Research of the Government and the Company

In early 1958 a silvicultural research was established as a cooperative project among the Bureau of Forestry, the U.P. College of Forestry and the Company with the following objectives:

(a) To obtain additional information regarding growth in volume, quality of products produced, commercial species relationship, effects of logging damage to the residual stand, effects of silvicultural improvement measures, stand structure, density of stand, species represented, effects of selection system as a tem of logging and reproduction response following selective logging;

(b) To determine the interval of time which should elapse between the selection cutting and silvicultural treatment of the residual stand to obtain best results at reasonable cost; and

(c) To obtain a basis for the selection of trees to be removed from the residual stand following selective logging in order to place the stand in a better condition for quality growth.

There were six 50m. x 50m. plots established in a setting logged by high-lead and 9 plots in a tractor-logged setting. The initial data indicated that diperocarps compose about 34% of the number of trees about 84% of the volume of the residual stand after selective logging. Remeasurement data after 5 years indicated that the periodic growth of the growing stock was significantly greater among the trees where timber stand improvement was conducted; and that periodic annual in growth or mortality for a dipterocarp residual stand may be as follows:

2.24% ingrowth every year for seedlings
1.96% ingrowth every year for trees 10 cms. d.b.h. class

1.75% ingrowth every year for trees 20 cms. d.b.h. class
1.74% ingrowth every year for trees 30 cms. d.b.h. class
1.51% ingrowth every year for trees 40 cms. d.b.h. class
1.19% ingrowth every year for trees 50 cms. d.b.h. class
0.81% ingrowth every year for trees 60 cms. d.b.h. class
0.36% ingrowth every year for trees 70 cms. d.b.h. class
0.24% mortality every year for trees 80 cms. d.b.h. class
0.67% mortality every year for trees 90 cms. d.b.h. class
1.03% mortality every year for trees 100 cms. d.b.h. class
1.33% mortality every year for trees 110 cms. d.b.h. class
1.70% mortality every year for trees 120 cms. d.b.h. class

The second remeasurement taken in mid-1968 are already submitted to the government cooperating agencies for analysis. In mid-1968 the Company proposed an expansion of the cooperative project to include block as well as treatment sampling and data analysis using standard statistical designs. Work on this proposed expansion may be started early this year.

Studies on Improvement Cuttings in Non-selectively Logged Areas

In the latter part of 1967, improvement cuttings was resorted to as a probable method of maximizing pulpwood production in areas logged previous to selective logging that are accessible and where the terrain is not so rough or where harvesting can be done by use of a tractor or timberjack skidder. Two 6-men crews, with a McCullough model 2-10 G chainsaw to a crew, cut and remove trees except those marked as probable crop trees. These crop trees are those of the intermediate type, of desirable pulpwood, vencerwood and saw timber species, healthy, without any damage whatsover, and judged to be the best trees in the three groupings at the time of thinning. Seedlings of dipterocarps are freed from overtopping trees.

Analysis of a 3-month operation thereat indicated that an average of 11.1 hectares can be improved in a month with a corresponding volume of 63.52 cu. m. thinnings and ₱1,972 expenses of which 9% was in tree marking, 19% in felling and bucking, 48% in underbrushing and thinning, 4% in carrying the bolts to the roadsides, 6% in loading, 7% in trucking or transporting to the log pond about 30 kms. away, 4% in unloading from pulpwood trucks and loading into pontoon barges, and 4% in towing to the factories. These expenses total about ₱188.61 per hectare while the thinning yield about ₱11.44 per hectare.

Data from the inventory-growth plots established in the improved areas indicated that per hectare basis the merchantable portion of the residual stand has a current value of ₱6,074.32 of which 9% is red lauan, tangile and malugai of at least 70 cms. d.b.h., 31.9% is almon, bagtikan, mayapis, nato, white lauan, narig, and palosapis, 0.9% is bitanghol, dangula, gisok-gisok, lamio. makaasim and oak, 1.7% is apitong, 2.4% is gubas at least 40 cms. d.b.h., and 4.4% is ilang-ilang, binuang, hinalumo, tulo and other pulpwood species at least 20 cms. d.b.h. The volume of the trees 20-70 cms. of the first species groups and those 20-40 cms. gubas is 93.21 cu. m. or 49.6% of the total stand-

ing volume but 95.8% of the total number of trees. These are now counted, however, in the computations for determining the value of the residual stand because these were allowed for as probable damage during harvesting.

OTHER PROJECTS

Experimental Cattle Project

The cattle project of the Company was started in 1965 with the following cattle population: bulls — 5, heifers — 37, or a total of 42. The bulls are as follows: Illawara Shorthorn from Australia — 2, and Red Sindhi from Dalupiri, Bataan — 3. The heifers are broken down as follows:

2 Illawara Shorthorn from Australia
4 Brahman Shorthorn also from Australia
4 Brangus from Australia
27 Red Sindhi from Dalupiri, Bataan

As of the end of 1968, the orginal herd of 42 increased to 80 heads. During late 1968, 30 heads of Sindhi heifers were brought in from Dalupiri making an aggregate of 110 heads as our cattle population as of the end of the year.

The cattle project is located in our lumbang lease area covering nearly 2,000 hectares. Our earliest lumbang plantings are now 12 years old. The Company's plan is to contain our present and future herd in only about 600 hectares where the topography is smoothly undulating.

Since the establishment of our lumbang plantation 12 years ago, we have been beset with the more serious problem of plantation maintenance. Cogon and talahib grasses have practically taken cover of the area. Hence, in order to control these grasses, cover crops had to be introduced as 1964. For this purpose some 50 hectares w,ere planted to kudzu. However, the scheme did not prove satisfactory as kudzu tended to climb the lumbang trees. And because of this, a radius of 5 meters from every lumbang tree had yet to be cleared of kudzu before any harvesting of nuts could be made.

For this reason, the Company, as early as 1964 thought of introducing a selected breed of cattle into the plantation for the main purpose of lowering the maintenance cost of the plantation. Our theory was that the cattle could keep the grass low making it unnecessary to use mechanized cutters while at the same time making it easier for harvesters to pick up fallen lumbang nuts. Presently, there are 128 hectares of fenced area divided into 16 compartments.

The results of the introduction of cattle into the lumbang plantation have, thus far, been most encouraging. For one, the grass is really kept low, making harvesting easy. And another, with a clean lumbang plantation, the trees appear healthier than those unpastured by cattle. It is also possible that the cattle manure has something to do with the improved growth of the trees. Until the present time, yield studies are still being conducted at the plantation. It is predicted that the yield would be higher among trees located within the pastured areas. Moreover, our thinking before that the cattle might do harm to the lumbang trees has been proven wrong. In fact, our experience

has been that they do not, in any way, destroy the trees. The cattle are well fed and look much better than those pastured in open grassland.

We are projecting the Third-Dimension Forestry concept in the application of applied ecology to give forest land its maximum productive utility.

The foregoing are some of the most important research projects that we have been carrying on.

In line with the long range operational program of the Nasipit Lumber Company, Inc., and its affiliates, fundamental, applied and developmental research became the background of our general program. We, therefore, must carry on and continue the work that we are now pursuing both in industrial research and forest development. Certain problems crop up as we go along which require more detailed studies. As there is a dearth of the necessary facilities, we have to avail of the services of other research institutions to help solve our problems. For instance, in our desire to find the maximum utility of lumbang oil and meal, we have to engage a foreign institution to carry on the research for us. We believe that there are certain objectionable features in the lumbang oil as a drying fluid. However, there is a great deal of potential in the oil as well as meal, if properly studied. In the kiln drying of lumber, there are many aspects to be learned as every wood species behaves differently under various treatments and these need furthr studies. The same is true in wood preservation, where absorption of chemicals as preservatives varies according to the different wood species.

There has never been much studies made on wood bark utilization. Our Company has recently acquired a good size debarking machine to debark every log that goes to the factory and and to find out what could be extracted from the bark. Results of our experiments on barks utilization are very encouraging attempt we have not adopted it yet in our operation. Unles barks are used in commercial operation they will remain to be waste in the industry.

In line with the forest development, it is sad to say that nothing much has been done on forest plant genetic. While agricultural genetic has been extensively established, no forest plant genetic has been done. Likewise, there has not been, as far as I know, concentrated efforts and studies on plant ecology in our forest.

CURRENT RESEARCH EFFORTS IN METAL FABRICATING AND OTHER METAL INDUSTRIES

By DANTE G. SANTOS

THE NEED FOR RESEARCH IN METALS INDUSTRIES

It is said that the amount of metal a nation uses is an index of its standard of living and degree of civilization. Without iron and steel, aluminum, copper, zinc, lead, magnesium and many other metals and alloys, this world would still be backward and primitive. A nation unable to produce or at least process metals into items of use would be backward, insignificant, and weak. The dependence of a progressive country and industrialized people on metals are so far-reaching that it becomes difficult to mention any aspect in life where metal does not play an important role.

A few illustrations of the vital role of metal in modern life given below, should also serve to define the very wide area of opportunity for industrial research work. The need for these research activities becomes more pronounced as developing countries strive for industrialization and economic self-sufficiency.

Food — From plowing of the ground, harvest, storing, distribution, preparation, cooking and consumption, metal is involved in many forms among which are the simple low and/or complex agricultural machinery, warehouses, cans, can openers, stoves, and spoons and forks.

Shelter — Domestic, industrial and commercial structure utilize many forms of metal. Buildings are then furnished with metal wares such as steel chairs, tables, metal lamps, pots, appliances metal beds, etc.

Clothing — Metal machineries and equipment manufacture synthetic material as well as weave and spin both natural and synthetic fibers. Metal equipment makes finished clothes, shoes, hats, etc.

Communication — Copper, aluminum, and other metallic alloys are used for wires, cables, telephone instruments, radios, telegraphic equipment and television. Paper and printing materials are produced by metal machineries.

Transportation — Ships, planes, buses, automobiles, bicycles are all made of metal.

Mining — Gas, oil, coal, and metal itself are extracted from the earth and processed by metal drills, der-

ricks, pumps, super-complex refineries and other processing equipment.

World peace or Conflict — depends on the availability of instruments of warfare made from metal. The very survival of a nation at war depends on her metal armaments and ammunition.

The foregoing dramatizes the extent and degree of progress attained between metal specialists and other special technologies. It also shows the scientific and technological gap between countries that have launched industrial research programs and countries who have neglected to put proper emphasis and support for such work. It is interesting to note that much of the breakthroughs in metal technology were made in countries without appreciable natural mineral resources. This fact should serve to inspire and motivate developing countries similarly situated to strive equally. For those developing blessed with metal resources, the extent and direction of research work is practically spelled out.

In the case of the Philippines, the need to develop the Metals Industry beyond the mining stage has been recognized as early as the start of the struggle to become economically self-sufficient. Among the directions planned for this massive struggle not only to rebuild the country from the ravages of war but also to attain self-sufficiency were:

1. Increase productivity of traditional agricultural export items.
2. Efficiently exploit mineral natural resources and process same locally rather than remain as a supplier of basic mineral ores.
3. Increase utilization of indigenous raw materials and consequently, reduce imports.
4. Develop industries to provide for gainful living for the exploding rank of employable citizens.
5. Increase industrial exports.

It is apparent that all the above objectives can only be attained if industrial research work can be successfully launched. The Metals Industry not only presents itself as one of the most fertile fields of development but more importantly, appears to be a major base for industrialization.

In this light, it would indeed be meaningful to evaluate the present status of the Metals Industry in the country. This paper shall treat specific areas where manufacturing activities appear to have been attempted with the view of bringing into focus the extent of industrial research work accomplished and/or the lack of it. At the onset, it should be mentioned that the extent of data or information that will be included would be limited to as much as may be gathered from recorded information available to the writer. It is, therefore, highly probable that there are many other vital and significant facts that may be neglected or omitted because up to the present time, there are no facilities where all this important information are systematically recorded. This may be one aspect that should be given serious consideration by the present workshop sessions.

METAL PROCESSING IN THE PHILIPPINES

The obvious role of metal processing in the industrial development of a country would bring to mind the following questions about the Philippines:

1. What is the extent of metal processing and fabrication in the Philippines?
2. What has caused this progress or lack of it?

As is generally known, the Philippines is blessed with a number of metal deposits, among which are iron, copper, nickle, manganese, and gold. The mineral deposits may not be the greatest in the world, nonetheless, these are obviously sufficient to warrant mining operations. Unfortunately, the farther processing of these ores into more "purified or reduced" forms for use in rolling and drawing mills have not been attempted. Among reasons advanced are:

1. Insufficient financial resources.
2. Economic feasibility.
3. Insufficient local market and inability to compete with other countries products.
4. Unavailability of technical know-how.

It would appear that some of these reasons can be rendered invalid if sufficient progress is attained in the heavy metals industries sector, the intermediate manufacturing sector, and finally, in the metal consumer and industrial goods sector. Significant activities in these various levels of metal processing will create a ready market for the basic metals industries possibly to the extent that it will warrant setting up of steel mills or reduction plants for local processing of ores into pig iron – ingot steel and billets of nonferrous metals.

A simplified flow of materials from mine to mill to end product manufacturers is herewith included to assist in visualizing the extent of complexity of processing and diversity of activities and products involving steel.

Up until lately, the Metals Industry in the Philippines has been limited mainly at the "End Use Products" level in the simplified chart. There are approximately half-dozen blooming mills producing bars, rods, end wires. The success of the blooming mill operations has been due to the significant market presented by the construction trade.

The industrial research work performed by the blooming mills has apparently been significant inasmuch as the range of sizes, specifications and types of products manufactured have met the varied requirements of the building and construction trades. Moreover, it appears that many of the necessary machineries, equipment, and tools are manufactured locally. Undoubtedly, the substantial ingot steel requirements of the blooming mills helped justify the setting up of the first steel mill being presently constructed.

There appear to be three (3) rolling mill projects initiated recently. Work on one of the three may have been slowed down while the second has been operating successfully supplying tin-coated materials to can-making plants. The third, a more ambitious project is momentarily expected to start opera-

tions of rolling. This project has plans to integrate vertically to produce pig iron and ingot steel from mineral ores. The implementation of this phase of the project will be a major step in the Metals Industry in particular and the industrialization program of the country in general.

STATUS OF METALS INDUSTRY-END PRODUCTS SECTOR

There are a number of manufacturing activities involving metal raw materials varying from straight forward metal fabrication (intermediate forms such as structural sections, building trusses, grilles, metal ducts) to machine tool manufacturing and home appliance manufacturing. Unfortunately, survey work involving these industries have been accomplished under varying objectives and reference data, consequently, unless these available information are further processed, a misleading trend may occur. The lack of more descriptive or categorized survey work may be one cause of the disappointing development of these various industries. Moreover, it is suspected that many of the industries were initiated under "artificial" conditions (import and currency control years). When controls were lifted in 1961, a number became distressed and may have closed shop.

The 1966 preliminary report of the Bureau of Census and Statistics on manufacturers shows a number of classifications which involve metal working (processing of metal sheets, wires, rods, billets, etc., into end-products or components or end-products). These are grouped according to finished products and may, therefore, involve operations beyond metal fabrication as defined. The industries list by the Bureau of Census and Statistics survey are:

Major Group	Number of Establishments	End-Products
Metal Products, except machinery transport equipment	347	Packers' cans made of tin and aluminum
		Cutlery, hand tools, and general hardware
		Fabricated structural metal parts
		Architectural metal work
		Stamped, coated, engraved metal parts
		Stamped, enamelled and lacquered metal products
		Fabricated wire products
		Heating, cooling and plumbing equipment (except electrical)
		Others, needles, pipes, fasteners
Electrical machinery, apparatus, appliances and supplies	155	Electrical industrial apparatus
		Electrical communication equipment
		Batteries, electrical pumps & lighting fixtures
		Household electrical appliances

		Household cooking, heating & laundry equipment, refrigerators, refrigeration machinery Household electrical appliances not elsewhere classified Miscellaneous electrical machinery, equipment, apparatus and supplies
Machinery except electrical machinery	167	Engines and turbines except motor vehicles, marine and aircraft Tractors and farm machinery Metal working machinery Special industry machinery General industrial machinery and equipment except electrical machinery Machinery except electrical machinery not elsewhere classified.
Transport Equipment	247	Bus bodies, trailers, barges, dump trucks, mine and cane car bodies; shipbuilding and repair, motorcycles, boars, motor vehicle assembly, etc.

It can be noted from the listing of end-products manufactured that in every category metal fabrication is involved in the process. It becomes evident that the development of the technology of metal fabrication may well spell the progress of such other more sophisticated metals industries as elecerical equipment (motors, generators, transformers), home appliances (refrigerators, air conditioners, freezers, washing machines, etc.), transport equipment (automobiles, trucks, barges, etc.) manufacturing. Unfortunately, there has been no communication or dialogue among the relatively few existing industries that should result in an exchange of ideas and identification and definition of common problems. This lack of much needed coordination and communication has resulted in the slow progress of the metals industry in the country. What may be worse is the useless dissipation of limited resources through duplication of efforts, duplication of vital machineries and equipment, disappointing returns on investment and consequent insufficiency of resources committed to the industry.

METALS INDUSTRY DEVELOPMENT CENTER

Recognizing the vital role of the metals industry in the industrialization program of the country, the Sixth Congress of the Philippines legislated in June 1966 R. A. 4724 – An Act to Develop the Metals Industry of the Philippines by Establishing the Metals Industry Development Center. This law declared it "a national policy to develop and expand metals industry of the coun-

try by maintaining close coordination with the private sector in putting up a non-profit research organization to provide both the government and the private sector with professional management and technical expertise on such vital activities for the development of the industry as training of engineers and technicians, information exchange, trade accreditation service, quality control and testing of metal products, research and business economics advisory services."

The "metals industry", as used in this act, includes the processing from ore into various metals and alloys, bullions, ingots, billets, slabs, thence to other intermediate forms of sheets, plates, strips, tubes, castings, forgings, extrusions, drawings into finished metal products such as various machineries, appliances, apparatus, transport equipment, hardware, utensils, tools, etc. To carry out the provisions of the Act, a special fund had been established known as the Metals Industry Development Fund consisting of government contribution of ₱1,500,000 upon approval of the Act and ₱1,000,000 annually for a period of six years. The private sector contribution, in addition to reasonable fees that will be collected for services rendered by the center, shall be ₱100,000 upon approval of the Act and ₱150,000 annually for six years. It is further contemplated that the private sector shall continue the operations of the research center after the government assistance shall have phased out.

Republic Act No. 4724, if properly and successfully implemented, provides a major step towards the solution of existing problems as well as establishes a long-range program that should coordinate the efforts of the various members of this industrial sector towards the full development of the metals industry. Among the major steps and activities contemplated are:

a. Business Economic Advisory Services – to provide various management and consultation services; periodic analysis of the progress of the industry, and to serve as liaison between the government and private sector for policy determinations.

b. Training, Information Exchange and Accreditation Service– to gather and disseminate information on technological developments; maintain a library of pertinent and vital information; gather statistics necessary for studies; train personnel to meet various industry manpower requirements; establish a development program and set investment guidelines that will result in a faster systematic growth for the industry.

c. Control and testing of Metal Products – to establish standards acceptable internationally; assist in establishing suitable production methods to improve quality and standardize products as required; to arbitrate in controversies arising between suppliers and users of metal products.

d. Metals Research and Development – to establish a research and development center that will serve the industry; to train personnel; to develop methods and techniques designed for maximum use of local raw materials and to reduce costs; to explore and encourage development of ancillary and/or tributary industries;

to assist firms which do not have facilities for research and development work.

From the foregoing information regarding the contemplated function of the MIDC, it would be reasonable to expect that the center will play a vital role in research and development efforts in the country's metals industry. Among the work MIDC has done has been to establish contact with the various industry groups and solicit information and assistance. The center has also started a survey program of industries and results were organized into status reports which should serve to acquaint the government and private sector with data about particular industries. The availability of this information will assist in the planning of other industries where a potential subcontractor/customer or supplier/customer relationship may exist. Policy determinations of the government can also be made more responsive to private sector needs or requirements.

MIDC has also initiated efforts and explored areas of cooperation among competitive members of industry groups. The vital area discussed is the field of research and product testing. It is generally known that the capital investments for a reliable testing and research facilities are substantial. Sharing capital requirements and operating costs of such facilities will obviously be beneficial to all concerned.

Research efforts or the insufficiency of it may be gathered from the various status reports accomplished by the MIDC. Significant observations and data from some status reports are herewith quoted.

METAL FABRICATION INDUSTRY

MIDC identifies the Metal Fabrication Industry as those firms engaged in the manufacture of metal products from metals such as aluminum and steel, utilizing any or all and/or combination of any of the processes of cutting, blanking, rolling to shape, flanging, bending, punching, welding, assemblying, cleaning, finishing, and crating. The various machineries involved are, shears, cutting torches, welding equipment, hydraulic and/or mechanical presses, benders, brakes, grinders, drills, shapers, hammers, materials handling equipment, painting equipment, etc

Products manufactured are storage and pressure tanks, building trusses and frames, towers grilles and gate metal ducts, trailer tankers, penstocks, steel liners, boats and barges, bridges, smoke stocks, conveyor systems, bus bodies, dump trucks, mine and cane cars, housewares, etc.

Survey reveals there are approximately 100 large and medium-sized companies engaged in metal fabrication with 30 utilizing aluminum material and 70 using steel materials. Most of the significant companies are in the Manila area with a few scattered in urban areas of the country. The raw materials used are aluminum and steel in the form of bars, rods, structural shapes, sheets and plates. Annex A is a table showing the source of raw materials classified into local manufacture and imported. The table reveals the relatively large quantity of raw materials being imported resulting in high cost

of inventory as well as import levies paid resulting in reduced earnings for the fabricators.

It would be safe to assume that among the reasons for the use of a substantial quantity of imported raw materials are any or a combination of any of the following:

a. Inability of local manufacturers to supply acceptable quality of materials.
b. Lack of supply at the time required.
c. Limited choice of forms or sections of locally manufactured materials, i.e., required specifications cannot be manufactured locally.

Experience of the writer in endeavoring to increase the usage of locally manufactured materials helped overcome some of the above stated reasons resulting in the substantial use of locally supplied metal extrusions, foils, sheets, and miscellaneous ornamental and hardware materials. Joint research and development efforts between user and supplier (manufacturer of raw material) resulted in the solution of many difficulties. The writer submits that in many cases the applications engineer of both user and supplier may have been guilty of being unreasonably inflexible about designs or specifications rather than rightfully develop mutually acceptable solution which in the long run would benefit their companies in particular and the country in general. A rapport established among all these parties may well lead to substantial progress beyond areas presently discussed resulting in faster growth. and development of these metal industries.

A specific sector of the metal fabricating group (steel home appliance manufacturing) will be discussed later in this paper.

MACHINE TOOL INDUSTRY

The machine tool industry is that sector engaged in the manufacture, repair and assembly of industrial machineries like lathes, grinders, drills, shapers, milling machines, power saws, presses, brakes, etc. These machines are used by industrial or manufacturing plants, engineering shops, tool shops, and repair shops. Machine shops are considered a part of machine tool industry inasmuch as it shapes metals with desired forms for use in industrial plant operations. Machine shops also maintain, recondition, and fabricate parts of machines or accessories for use again in fabrication of metal products.

As of November 1966, there were surveyed three (3) establishments engaged in the manufacture of machine tools. Lathes, grinders, and drill presses were manufactured by one that finally had to close shop being unable to maintain the operations feasible. The remaining two (2) continue to produce small drills, mechanical and hydraulic presses. Machines are produced on special order basis but apparently none of these shops have obtained sufficient orders to provide the opportunity to produce at full capacity thereby making difficult to determine their capacities.

In the face of problems and need for support from both the government and private sector, machine shop owners formed an association whereby they can collectively present their cases and communicate among themselves and

the industry (metal fabricators) they hope to serve. The estimated membership of the association is approximately a thousand.

The efforts of the country to industrialize will eventually result in an increasing demand for machine tools. As industrial plants grow and increase in number more specialized machine tools will be required for improved efficiency and profitability. Demand for maintenance equipment and specialized engineering services for tooling will increase and bear on independent machine shops.

The quantity and value of importation over the past few years for machine tool equipment, accessories, tools, cutters, and bits are as shown in Annex B. These import figures reveal the potential of the machine tool industry in the country in terms of growth and the valuable contribution to the economy, among which are:

a. Dollar Savings presently estimated at $7.5 million annually.
b. Added employment.
c. Technological growth.
d. Use of local materials or serve as a substantial customer of the basic metals industry.

The writer submits that the slow progress and growth of the machine tool industry in the country are due to the following:

a. Insufficient technical competence of the machine operators and managements of the firms. Most of the machine operators are incapable of reading and interpreting technical drawings and specifications. Proprietors/managers come from the ranks and do not possess required managerial know-how.
b. Insufficient knowledge of special characteristics of metals and corresponding applications of men in charge of operations.
c. Insufficient information of market or demand (forecast) which is needed for efficient planning of operations.
d. Insufficient financial resources.
e. Lack of facilities for necessary product development and special treatments of metals.
f. Lack of coordination with customers and suppliers (local foundries and others.

The foregoing shortcomings clearly dictate the need of special training institutions where machine tool operators, technicians, engineers and designers can be given more sophisticated training in the various aspects of the machine tool manufacturing techniques. It is unfortunate that possibly the people engaged in machine shop work are not fully aware of these special demands on their industry, consequently to this date, the writer is unaware of any serious attempt being undertaken by these people to organize or set up such an institute. Unless this program is seriously undertaken, the lack of talent in this field will prevent the local machine tool industry to blossom into a meaningful and significant sector.

The problem of market may not be properly appreciated at the moment as there has been no cause to undertake serious marketing efforts by the industry. As regards pricing, the writer has had the experience to compare

and purchase locally manufactured mechanical presses. The locally manufactured presses met specifications at more advantageous prices, considering shipping, crating, and import levy costs. Further, the writer has observed larger and more sophisticated locally manufactured machines with satisfaction. As a result, the purchase of a 200-ton hydraulic press is now being seriously considered.

Communications with potential users must be seriously undertaken by the machine tool people. It should be appreciated that the more machines they manufacture and supply, the more opportunity for field research and studies to improve their products. This is an accepted system and has been the pattern of development and growth of most machine tool industries in the world .

MANUFACTURE OF ELECTRIC MOTORS AND GENERATORS

This industrial activity is concerned with the manufacture of electrical equipment which serves as prime mowers (motors) for machinery and equipment of various sizes and which serves to transfer mechanical energy generator) to electrical energy. Large capacity motors are identified with industrial equipment and have a relatively limited demand. There is, however, a substantial demand for fractional horsepower motors used in various applications such as electric fans, air conditioner blowers, floor polishers, exhaust blowers, etc. The use of generators are generally limited to approximately 420 electric utility companies in the country.

Motor manufacturing was seriously started by two firms approximately ten years ago. Presently, only one remains and is operating at a fraction of plant annual capacity of 6,500 integral and fractional horsepower motors on an eight-hour shift. The firm manufactures floor polishers utilizing motors they manufacture. It has also ventured into the manufacture of distribution transformers, are and spot welders and water pumps. Unfortunately, the firm has apparently been unable to supply the requirements of the room air conditioning industry which is estimated to be 40,000 units annually for new motors and 10,000 units for the replacement market.

The demand for motors of various sizes can be gleaned from importation and local production figures. Annex C show these data and should indicate the market potential in the country for electric motors. There is a good reason to believe that a large percentage of imports are used by the room air conditioning industry.

Studies indicate that there is a growing market for small electrical equipment in the category of motors for blowers of room air conditioners, electric fans, floor polishers, and small transformers, including ballasts. The estimated present annual market (growing at approximately 25%) for this electric equipment are as follows:

1. Motors for electric fans	50,000/yr.
2. Motors of room air conditioner blowers (new equipment)	40,000/yr.
3. Replacement motors for room air conditioners	10,000/yr.

4. Other small motors (washing machines, exhaust blowers, pumps, floor polishers, etc.) 20,000/yr.
5. Transformers 50,000/yr.
6. Ballasts (for fluorescent fixtures) 250,000/yr.

Inspite of this immediate market that may well justify investments for a manufacturing company, there appears to be no serious attempt on the part of the "electrical" industry to set-up suitable manufacturing operations. Admittedly, even such demand may not warrant investments in terms of American, European, or Japanese standards of operations, nevertheless, there is very reason to believe that a viable manufacturing venture can be established in the Philippines. One merely has to look around to see that many other industries have been successfully established and operated under the same apparent disadvantage.

Among the reasons why the "electrical" industry has not developed beyond its present status may be any or a combination of any of the following:

a. Insufficient financial resources.
b. Inability of firms to make firm commitment on delivery and pricing, thereby win customer's confidence.
c. Insufficient technical know-how.
d. Special laws that encourage end-product manufacturers to manufacture their own motors, transformers and other accessories.
e. High cost of local raw materials thereby rendering prices uncompetitive against imported counterparts.

The above clearly defines the need for more intensive research and product development in the industry. Initially, efforts must be placed in getting acquainted with the varied specifications for each application. This information should serve to direct the research and development program that should culminate in the manufacture of reliable motors at competitive prices. The need for high-cost sophisticated winding equipment may be avoided by (market may not warrant such high-speed equipment) utilizing simple low-cost winders and hand insertion of coils thereby reducing requirements for capital investments.

A number of home appliance manufacturers are presently manufacturing some of these equipment for their own use within very limited budgets of expense and capital investments. However, some of them, if not all, may prefer to have an independent manufacturing firm supply them, provided prices are reasonable and specifications are met.

The Electrical Equiment Industry may be compared to the Machine Tool Industry as regards to the vital role it plays in the industrialization of a nation. It is, therefore, imperative that this industry be given encouragement and support by both the government and industrial sectors. The government can encourage and support this vital industry through the following:

a. Tax-exemption privileges during the initial years or classify the industry as a "pioneer" industry.
b. Low interest on long-term loans for working capital and necessary machinery and equipment.

c. In the case of the Refrigeration and Air-conditioning Industry which, according to the law is required to manufacture its motor and transformers requiremenets within its corporate structure to avail of the percentage tax relief, said provision should be amended. The amendment must stipulate that the percentage tax relief will be extended to the Refrigeration & Airconditioning manufacturers who utilize locally manufactured motors, transformers, and other electrical equipment or accessories. Other provisions of the law remain in full force and effect.
d. Assist the industry in setting-up suitable research, testing, and product development facilities.
e. Grant the industry petitions for reasonable tariff protection.

The private sector (potential industrial customers) can lend support by the following:

a. Support research and development work to enable Electrical Equipment Industry to supply the requirements.
b. Make end-product designs suitable for available motor models and specifications.
c. Maintain flow of information to keep the motor manufacturers aware of the trend of end-product requirements for such equipment and accessories.

There is every reason to believe that the Electrical Equipment Industry has presently a good base for viable operations. There are sufficient potential suppliers and subcontractors for the industry. There are two existing electric wire manufacturers, a number of machine shops to supply shafting components, foundries or die-casting shops for motor housings or end-belts. The only apparent import requirements are bearing components, overloads, and other small special accessories.

SHEET METAL APPLIANCE INDUSTRY

While this industry may fall under the category of metal fabricators, a special section is herewith devoted to it inasmuch as the manufacturing processes, research and product development involved are different from straight forward metal fabrication. In the same manner that while sheet metal fabrication is substantial in the manufacture of automobiles and trucks, the industry is rightfully classified as the Automotive Industry. The Sheet Metal Appliance Industry shall then include the Refrigeration and Airconditioning Industry and the Cooking Appliance Industry.

The Sheet Metal Appliance Industry comprised of firms engaged in the manufacture of domestic refrigerators, freezers, room air conditioners, cooking ranges, and commercial beverage coolers. A substantial portion of the manufacturing process of these firms is metal fabrication of the major components and parts. Operations involved are cutting, blanking, notching, punching, bending, drawing, spot-welding, arc-welding, gas welding, grinding, baking, vitreous enameling, painting, assembly, testing, and crating. Machineries and equipment utilized in manufacturing operations are shears, presses of

various types and tonnages, tools, gas welders, spot welders, grinders, sanders, chemical baths, painting equipment, baking ovens, furnace and other varied special equipment.

Survey shows that there are twelve firms engaged in sheet metal home appliance manufacture and approximately ten firms specializing in electric home entertainment manufacturing. Most of these firms are located in Metropolitan Manila and suburbs. Manila area being the major port of entry for imported raw materials as well as representing 50%-60% of the total market of the country.

Most of the home appliance firms are related to American corporation as licensees and/or partners and/or wholly owned. These relationships provided the local firms with the initial needed technical assistance in factory organization and product engineering support. As the local firms acquired the know-how and necessary financial resources, local work on industrial research and product development was initiated with the foreign companies lending assistance where necessary.

Nine of the firms formed an association named after a similar newly-organized group which succeeded the NEMA. The Association of Home Appliance Manufacturers, Philippines was thus patterned after AHAM, United States, with objectives of setting quality and performance standards for the various products. The goal of the local association is to set up a suitable research and test center for vital components and end-products. Test procedures which includes engineering limits for accessories, and end-product ratings to be patterned after AHAM, United States practices.

Some members of the industry manufacture electronic entertainment equipment and cooking appliance to round-up product offerings to dealers as well as to optimize utilization of existing manufacturing facilities. A limited range of electric cooking appliances are presently beng manufactured. No gas (LPG) cooking appliances are being manufactured locally inasmuch as the landed cost of Italian products are quite low rendering local manufacturing operations uncompetitive.

Annex D is a survey of estimated sales and production of various steel home appliances and other products manufactured by the industry. It will be noted that while there is a relatively large market for LPG cooking appliances, no local manufacturing is presently being done.

Both the Refrigeration & Airconditioning Industry and the Electronic Equipment Manufacturers are provided an incentive to engage in continuous industrial research and product development to increase local content, i. e., increase the local manufacture of components and accessories utilizing local and imported raw materials. The incentive is provided in terms of percentage tax relief which allows relief of as much as 75% of sales tax rates depending on local content or degree of "integration" of manufacturing activities. Great strides have been attained since the effectivity of the law providing for the incentive, resulting in substantial use of local materials, increased local labor consent, and development of local technical know-how

of the industry and supplier or tributary industries. Illustrations of industrial research efforts are in the following areas:

1. Low-cost tooling to suit low production volumes.
2. Joint efforts with paint manufacturers for specialized finishing materials to suit available curing (baking) facilities.
3. Joint efforts with local industrial chemical companies for chemicals suitable for necessary "bonderizing" treatment of metal surfaces.
4. Joint efforts with aluminum rolling and extrusion plants to develop suitable aluminum sections for heat-exchange (evaporators) use.
5. Research work to develop facilities and techniques for processing of special insulating materials (expanded polysterene and/or foam-in-place urethane).
6. Joint efforts with box or carton manufacturers to develop suitable boxing materials.
7. Research work to develop facilities and techniques for proper processing and building up of refrigeration systems.
8. Research work to develop facilities and techniques for the manufacture of heat exchangers (evaporators and condensers) for both refrigerators and room air conditioners.
9. Research work to develop skill and techniques in plastic extrusion, compression molding, and vacuum forming.
10. Joint efforts with aluminum die-costing shops for the high-speed castng and plating of various ornamental accessories of the products.
11. Research work to develop products suitable for the market.
12. Research work to develop facilities and techniques in product testing.
13. Joint efforts in research work with wire-drawing plants for the manufacture of suitable specially insulated wiring materials for hermetic motor manufacturing and special transformers for electronic equipment.
14. Market research work and product performance field-work to determine customer habits and needs.

Most appliance firms conduct individual research work continuously in varying degrees. On certain occasions, when common objectives or desired information are discussed, joint or cooperative research work ensues. Unfortunately, competition among the members of an industrial group goes beyond objective limits resulting in lost opportunity to explore areas of joint efforts and cooperative undertaking of necessary expenses in the research work. There is every reason to believe that pooling of talents and resources of specific sectors, which undoubtedly will result in the mutual advantage of the individual members, is possible if a qualified interester "third party" can guide or maintain an objective approach to certain areas of industrial research work.

Along this though, AHAM, Philippines is presently seriously considering an ambitious project of setting up a complete research, testing, and product

development laboratory of facilities. The project is expected to require substantial investments much more than any single firm can afford or would care to undertake. The membership has expressed full financial support as well as the necessary know-how and is planning to solicit support from the government sector, through the MIDC. Plans include the invitation of related professional societies to take active roles in operating the Research and Test Center. The professional society, in cooperation with the government sector, then takes the role of the qualified "third party" to ensure that no individual company may use the facilities for any selfish motive. The Center shall serve to ensure that work shall be confined in terms that will benefit the general membership and advance the technology as well as to disseminate scientific and technical information. This shall include information which will guide and inform the public in official terms the rating, warranties, and safety of industrial products sold in the market.

CONCLUSION:

The foregoing are observations of the status and problems of certain groups of the Metals Industry sector. It can be noted that many problems are common among all, significant among which is the lack of communications among the members and with the government sector.

The writer feels that the government sector has been apathetic towards the role of organizing these various industry groups or their potentials and capacities for industrial research into a meaningful resource for industrial development. Possibly the government sector has failed to recognize such potentials. On the other hand, it appears that the private sector has ceased turning to the government sector for assistance in research work inasmuch as it has become a general feeling that government activities are generally politically motivated. These impressions are possibly due to the observations of the private sector that government activities in industrial and scientific research do not appear to be within the scope of the present or the direction of activities of the industrial sector.

PROBLEMS

A. *Private Sector*

1. "Emotional" aspect of competition among industrial firms have prevented an objective approach towards industrial research work. This "immaturity" of various firms have prevented industry associations, purportedly formed for solution of common problems, to establish proper communications among members so that positive steps can be taken with regard this shortcoming.
2. Most industrial firms have taken research and development work for granted, i.e., no formal program nor resources are committed for research work and new-product development.
3. Industrial firms have failed to work with, or failed to appreciate the potential of working with universities or branches of government responsible for research and scientific work. Too few industrial firms have

made grant sto universities for scientific or research work.

4. Industrial firms have depended too much on foreign associates as a source of information regarding new-product portfolios and solutions to problems inherent to local conditions.

5. Insufficient investments or resources are committed to advance the training of technical men. Many firms would rather "pirate" men from other firms as the need occurs rather than institute a program of technical development towards direction of industry plans and/or growth.

6. Industries fail to motivate scientists and research personnel.

7. Failure to avail of government assistance in terms of facilities and scientific personnel.

B. *Government Sector*

1. Inability or lack of resources to develop, motivate and supply necessary facilities to scientific and research personnel.

2. Inability to prevent encroachment and/or meddling of "insincere" politicians in research activitiees.

3. Legislations and/or regulations designed to benefit only certain politically powerful private industries to the disadvantage of the other competing industries have been made into law or officially enforced.

4. Potential resources specifically granted to set-up facilities and undertake investments in industrial research and scientific work have not been availed of or have been diverted for some other use. Among these are resources from reparations, special funds granted or extended by friendly foreign government.

5. Failure to motivate or provide incentives to industries for industrial research and scientific work.

6. Failure to set-up and maintain a reliable information center that serves various industry studies, academic work, and other planning work by the government and private sectors. Present sources or government branches and instrumentalities (Bureau of Census & Statistics, Central Bank Statistics, Statistical Centers of various government branches) have failed miserably to obtain accurate and current figures.

C. *Universities and Schools*

1. Failure to organize and commit proper resources and efforts to set up scientific and research work personnel and facilities.

2. Failure to review and up-date school curriculars to suit present levels or status of industry and government requirements, technological progress and specialized fields of learning.

3. Failure to maintain and motivate capable school personnel (instructors, professors, and scientists).

4. Failure to disseminate new and valuable information coming from research and scientific work.

5. Failure to communicate and/or obtain information as to the current needs of industry in research and scientific work which might be undertaken by the university. Failure to obtain assistance and cooperation in

the form of grants, special financial assistance, and facilities that may be provided by the industry.

RECOMMENDATIONS

There appears to be no need to make specific recommendations. The enumeration of the various problems above should also provide the obvious recommendations.

In closing, the writer wishes to express sincere appreciation for having been given the opportunity to participate in this workshop for and in behalf of the Metals Industry group. The writer also feels confident that the members of the Metals Industry group would be most willing to cooperate in whatever form necessary in efforts that may be undertaken to improve the status of industrial research and scientific work in this country. It should also be added that this group feels that such endeavors are long overdue and every effort must be exerted by all concerned to support this worthy project.

WP-m-45

Table 1

Local Production & Importation of Primary Steel Products for Fabrication
(In Metric Tons)

	Bars and Rods		*Structural Shapes & Sections*	
Year	*Imports*	*Local Production*	*Imports*	*Local Production*
1963	28,427	94,610	22,568	34,142
1964	45,822	99,610	63,856	34,559
1965	51,194	124,299	30,392	43,068
1966	70,005	132,690	9,335	—
1967	53,564	157,918	50,609	—

	Sheets and Plates	
Year	*Imports*	*Local Production*
1963	168,464	87,872
1964	294,727	134,553
1965	232,960	162,542
1966	233,483	183,896
1967	264,184	179,945

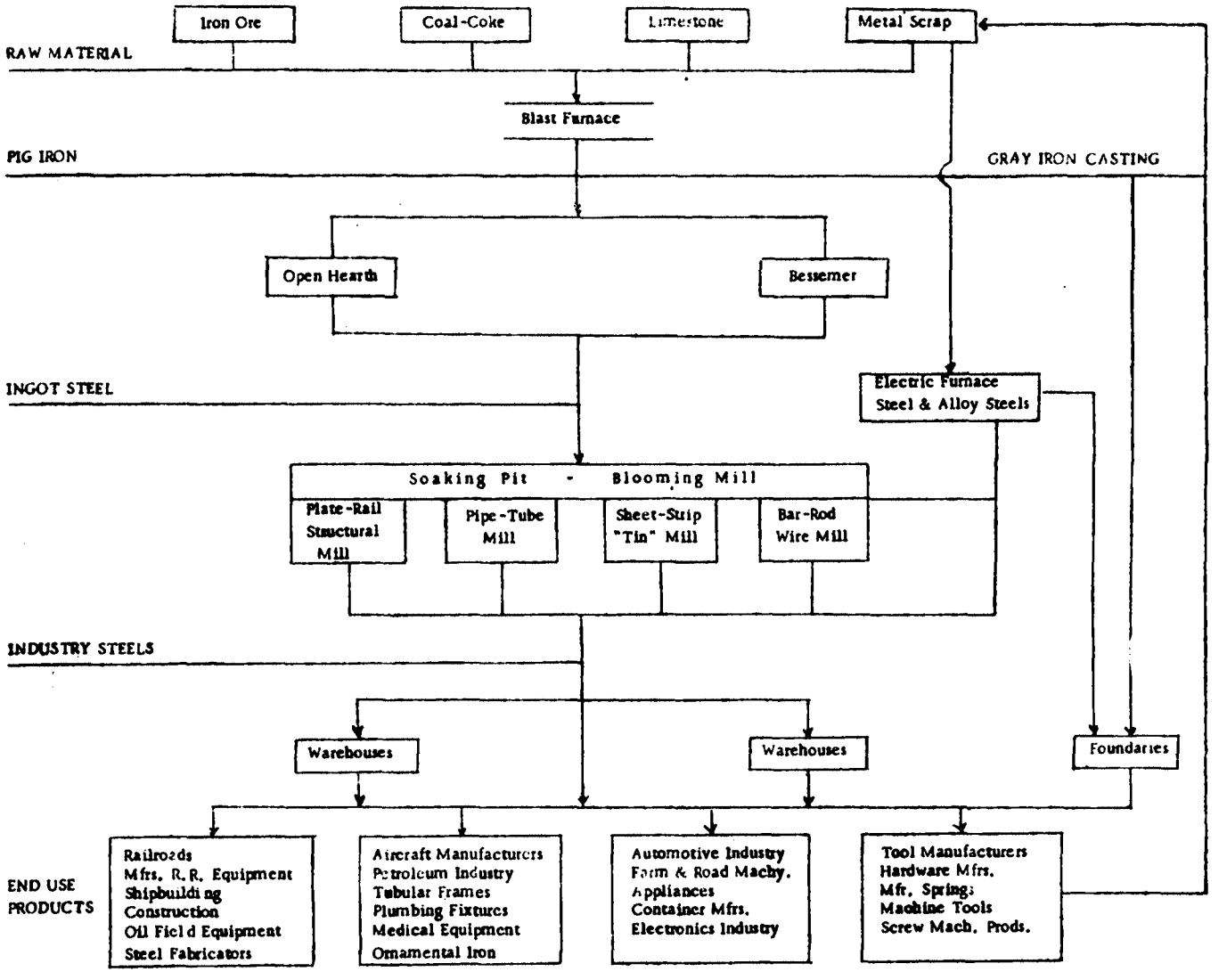
Table 2

Aluminum Imports

Year	*Quantity (MT)*
1963	6,168
1964	6,757
1965	7,166
1966	8,934
1967	8,163
1968	10,884

Source: Central Bank Import Figures and Survey of Local Producers.

PROCESSING AND DISTRIBUTION OF STEEL



ANNEX "B"

Table I

Machine Tools and Parts Importation

Year	*No. of Units*	*Value*	*No. of Kilos*	*Value*
1960	8,135	₱ 1,548,328	18,205	₱173,122
1961	20,441	3,267,192	33,326	243,756
1962	14,529	4,257,896	53,465	503,640
1963	3,895	4,270,878	15,734	209,286
1964	17,396	7,123,549	44,044	426,746
1965	7,590	10,516,334	151,041	435,918
1966	17,816	5,688,550	94,130	691,271

Table II

Machine Tool Accessories Importation

Years	*No. of Dozens*	*Value*
1960	261,252	₱1,235,498
1961	181,087	1,899,163
1962	60,521	2,372,216
1963	104,872	2,474,706
1964	80,325	2,429,552
1965	48,293	1,481,852

SOURCE: Central Bank
Machine Tool accessories include lathe tools, bits, dies, taps and press tools.

ANNEX "C"

WP-o-48

Table I

PRODUCTION AND IMPORTATION OF ELECTRIC MOTORS

Year	*Production* - (No. of Units)*	*No. of Firms*	*Importation** (No. of Units)*	*Supply*	*% Share of Production*
1960	n.a.	—	13,276	13,276	—
1961	16,441	2	28,419	44,860	36.6
1962	8,054	2	20,659	28,713	28.0
1963	2,439	1	39,530	41,969	5.1
1964	2,009	1	47,490	49,499	4.0
1965	2,277	1	45,640	47,917	4.7
1966	1,749	1	87,205	88,954	1.9

Table II

IMPORTATION VALUE OF ELECTRIC MOTORS AND SPARE PARTS**

Year	*Assembled Units*	*Spare Parts*	*Total*
1960	$1,023,032	$183,825	$1,206.857
1961	1,021,822	221,004	1,242,826
1962	1,196,442	212,830	1,409,272
1963	1,427,964	247,862	1,675,826
1964	2,233,441	437,534	2,670,975
1965	1,770,553	276,072	2,046,625
1966	1,656,684	373,089	2,029,773

* 1961-1962 figures are taken from the Bureau of Census. 1963-1966 figures from actual survey.

** Source: Central Bank.

ANNEX D

LOCAL PRODUCTION & SALES
OF HOME APPLIANCES LISTED
(NO. OF UNITS)

	1964			1965			1966			1967			1968		
	Total Sales	Local Production	Imported Units	Total Sales	Local Production	Imported Units	Total Sales	Local Production	Imported Units	Total Sales	Local Production	Imported Units	Total Sales	Local Production	Imported Units
Room Air Conditioners	20,000	18,500	1,500	23,000	21,000	2,000	25,000	23,000	2,000	28,000	26,000	2,000	36,000	33,000	3,000
Refrigerators	27,000	25,000	2,000	30,000	28,000	2,000	32,000	30,000	2,000	37,000	35,000	2,000	43,000	41,000	2,000
Freezers	2,500	2,000	500	3,000	2,500	500	3,500	3,000	500	5,000	4,000	1,000	6,000	5,000	1,000
Electric Cooking Appliances	1,700	1,200	500	2,000	1,500	500	2,500	2,000	500	2,500	2,000	500	3,300	2,500	800
LPG Cooking Appliances	n.a.	n.a.	n.a.	15,000	-	15,000	20,000	-	20,000	23,000	-	23,000	25,000	-	25,000
Television sets	25,000	20,000	5,000	29,000	24,000	5,000	30,000	25,000	5,000	35,000	30,000	5,000	45,000	40,000	5,000
Stereo Sets	13,000	10,000	3,000	16,000	14,000	2,000	20,000	18,000	2,000	21,500	20,000	1,500	23,000	22,000	1,000
Radios	220,000	200,000	20,000	205,000	180,000	25,000	195,000	170,000	25,000	180,000	150,000	30,000	150,000	100,000	50,000

NOTE: A SUBSTANTIAL PORTION IS "TECHNICALLY" SMUGGLED INTO THE COUNTRY.

Source: Industry Survey
AHAM Report.

RESEARCH EFFORTS IN INDUSTRIAL CHEMICALS AND ALLIED PRODUCTS*

By VICTOR G. GUEVARA

It will be in proper order to first give a general picture of the chemical manufacturing industry as it stands today – the development, the present number of plants, geographical distribution and approximate sizes. Our foreign participants would have to be oriented to small-scale thinking. After seeing the impressive list of names among Fortune's top 100 corporations who are represented here, it will be quite an ordeal to think small.

Prior to our independence 22 years ago, our economy was purely agricultural and about the only chemical products were alcohol and distilled spirits from fermentation of molasses. The manufacture of industrial heavy chemicals, synthetic resins and allied products came into reality very late – we can say, only in the fifties. Political independence, tied up with economic independence and the establishment of foreign exchange and import controls on the war ravaged young republic, forced the establishment of manufacturing industries. The chemical industry took its share of that program. It was during this period that the heavy basics like sulfuric acid, caustic-chlorine and calcium carbide came into being. These were certainly small plants, uneconomical by the standards our guests are accustomed to and we could say that only by adequate and fairly high tariff protection could they have survived. But the market was small – per capita usage is tuned to the low income of the masses – available capital was limited but nevertheless, the desire to conserve foreign exchange and start somehow got these manufacturing plants on stream. The Philippines was not alone and this could be said of all the post war, independent developing nations. Everyone placed emphasis on the manufacture of industrial products that could use local raw materials, tap energy sources and its abundant talent and muscle power.

Our first sulfuric acid plant was based on U.S. (Chemico) technology and was designed to use pyrites. This unit was in connection with ammonium sulfate production of 40,000 tons per year. Ammonia had to be produced from hydrogen by water electrolysis, an obsolete process even then, but that was the only power intensive process that could be thought of and it had to take up the output of the Maria Cristina Hydro in North Central Mindanao which the government declared had to be developed.

The first calcium carbide plant was put up in the same area at the same time. This was based on Norwegian know-how. It had a 10,000-ton per year capacity but for some time, the plant had to be operated at 60% capacity. The reducing agents used are coconut shell and wood charcoal. Limestone is abundant all over the archipelago and the materials for carbide were found right in Iligan City itself.

* A paper delivered by Mr. Victor G. Guevara, Executive Vice President of Mabuhay Vinyl Corporation. Mr. Guevara has been connected with the chemical industry since 1953. He and his father, Judge Guillermo B. Guevara founded Maria Cristina Chemical Industries, the first and up to now, the only Calcium Carbide producer in the country. Mr. Guevara served as plant manager and then general manager up to 1965. In 1965, he transferred to Mabuhay Vinyl Corporation where he managed the completion of construction and start up of the caustic-chlorine-PVC plant.

The first caustic-chlorine plant was established about a year earlier than the sulfuric acid and calcium carbide plants. But this was in the Manila area and this unit had to be trimmed down in size, to 2,000 tons a year because of the chlorine imbalance.

Today, there are three sulfuric acid plants based on pyrites, all tied in with fertilizer production. The one in the Bataan peninsula is owned by ESSO. The other in Cebu is tied in with the copper mine owning the pyrites and there is the original pioneer in Iligan. Two other sulfuric acid plants based on imported elemental sulfur are located in the outskirts of Manila.

There is still one carbide producer but capacity has been doubled – to 20,000 tons a year and this capacity has been in full use since 1967, supplying acetylene to a polyvinyl chloride plant nearby which went on stream in 1966. This company is a 50-50 joint venture between Union Carbide and Pilipino interests. Carbide is also used to supply the total acetylene black requirements of Union Carbide's EVEREADY battery plant in Manila. Acetylene happens to be still the only olefin produced.

More caustic-chlorine plants were established in the sixties. The PVC plant in Iligan had to have a chlorine source and is now operating at the capacity of 8,000 tons a year. Another De Nora designed plant in Luzon has a capacity of 18,000 tons a year but the full capacity is not yet used because of the chlorine surplus. The two merchant plants have tried everything to produce chlorinated products, ferric chloride, potassium perchlorate, ammonium chloride, calcium chloride but quantiy-wise, these are peanuts and there is still a surplus chlorine situation. Hopefully, the industry expects to balance this by early next year.

The most recent major and basic production unit is a 6,000-ton a year fatty alcohol and plasticizer (for PVC) plant using coconut oil feed. This is based on Kao Soap's hydrogenation technology. The plant is located in Lucena, Quezon, a coconut territory. It is still undergoing birth and growing pains having been inaugurated three months ago.

Alkyd resins are produced by five plants. There are numerous paint and pigment plants but the more signifiacnt in size are those tied in with foreign American brands like Sherwin Williams, Fuller, General, Finch, etc. These plants use more extensively imported materials. Almost all are located in the Manila area.

This is the picture of the industry I was asked to talk on. It is a young industry, most plants are fairly new (except the water hydrolysis which had to be scrapped when the power market developed. Ammonia is now produced by steam reforming imported naphtha) scattered all over and with the exception of the ESSO fertilizer unit, could be said, small in size, undercapitalized and still feeling their way though. Many are still losing money or breaking even. Almost all are short in patience in getting into the black. In other words, the plants that comprise the industry are operating on a shoestring and with the Central Bank circulars of 1968 and retrenchment of banks in loanable capital, the string certainly is very thin.

One can appreciate the situation for industrial research as we imagine it to be for this workshop under such conditions. There is no company big

enough to afford it. There can be no unified effort because the Filipino mentality in competition is a dog-eat-dog attitude. No one company in this sector has any formal R and D program nor budget nor existing physical facilities for anything but crude and basic applied research. To our Mister Moneybags, operations come first and foremost and rightfully so. All resources are channeled to just keep going.

But this is not to claim that applied research is nil. I merely said there is no formal budget nor planned effort as you know it or we in the industry would want it.

My company is probably typical of about a dozen in the industry. Instead of a fancy R and D Division, we have a so-called Project Engineering Office. This is like a research organization, separated from operations. It is staffed by a small (six) but permanent brainey engineers, graduates from manufacturing operations. Other companies have floating staffing, talents picked out from quality control or plant engineering or even technical sales. The specific mission of our office is like an R and D organization. They read immensely to keep abreast with this fast-moving technology and study improvements in efficiencies of processes, development of new products (in our case, new polymers and co-polymers as well as application of production resins) and utilization of by-products. It is responsible for all capital purchases and construction. This may sound like a tall job and it is, but limitations force us to compare this — what a local ordinance is to a national law. It is a pure applied research effort in search of quick results and highly profit-oriented or profit-conscious. It is a down-to-earth arm of the company. There are no Ph.D's but we have, as mentioned earlier, the brainiest in the lot. After completing a study, defending the appropriations and getting it, it is also in charge of construction until the project becomes operational and is accepted by the production department.

We have a product development laboratory which costs the company 6 to 7 per cent of total assets. This is probably higher than what the other colleagues in the industry spend on product development. This is a complete plastics fabrication plant with two types of compounding equipment — two extruders and attachments to make tubes for bags, pipes up to 4" diameter, plain and corrugated sheets, etc. We run these machines to demonstrate the art of fabrication to customers, prospective and actual and this has helped our selling arm. With fast development in stabilization and plastification of PVC by new materials and techniques, we have helped customers reduce production costs or improve product quality. We are not in commercial production but these are not pilot but commercial size machines. We have also turned out good finished products for internal use out of our off-grade resins and even in this respect, this 6 to 7% investment has paid off in the two-and-a-half years it became operation.

When a new Central Bank circular forces our treasurer to retrench and shrink available working capital, this office is the sacrificial lamb and is first to get the scissors. This is a heck of a way to run an office so we choose not only the brainiest but the most patient and understanding people to cope with such flexibility.

Short as the industry is on capital, it is abundant in ingenious talent. While almost all projects start with purchased know-how from abroad, the country's educational system turns out more of the regular technical talents than the industry can absorb. Thus, it is said that next to sugar, lumber and copra, we export medical and engineering brains to the U.S. and Canada and musicians to South East Asia. Although I agree with Mr. Zialcita that much could be desired in quality specially of specialzied talents for R and D work from our schools, I feel that for the practical down-to-earth plant operations, the adaptability of the Filipino technologists is good. Most plant expansions and new production facility — for increased capacity or new products, are done by local talent. In many cases, because the local engineers have had time to orient the process to local conditions and are the best judges as to how simple or how much to go by way of instrumentation and automation, the expansion or new facility turns out to be a more sensible job than the original. It is my observation for instance, that foreign plant designers could not remove from their minds the wind and snow loads in their own countries that more funds are channeled to buildings than should be. Some plants are too highly instrumented and automated. That is alright for labor rates existing in their countries but under our present conditions, it is too far ahead of time. It isn't at its optimum economics. There is no question — a little more importance and effort in Research would pay off but the Philippine entrepreneur is too much in a hurry to get things done and has to pay for this hurry.

Now comes the all important question. In what way can the NSDB assist these strugglers of research? I would say plenty. Now many can afford an IR or atomic absorption spectrophotometer or such sophisticated gas chromatographs but these are needed. It came to pass that in late 1967, all the three caustic-chlorine plants suffered serious setbacks, damage in equipment and production stoppage or setbacks when the salt supplied from one source contained a large dose of heavy metals — chromium — which was poison to mercury cells. We knew it was chromium as we had a spectrophotometer but no one else had it nor the know-how in detecting it and we were branded as partial. We three caustic-chlorine producers and the two salt producers decided to set a standard but we never came around to the facility to measure and do the corrective action. We could have the NSDB umpire and at least tell them the amount of poison, even if it could not, at the present, tell the salt producer how to remove the poison. At least, the salt makers would know what the undesirable element is and perhaps conduct research on how to remove it. As it is, we had to import salt from India for blending with this production from that region and we do not know what 1969 has in store for us.

I would like to cite a case of an industrial research project involving the government, which came up with a happy ending. The Philippine government in the early sixties, was a recipient of a pilot charcoal briquetting plant under the Colombo plan — a contribution of the British government. The plant was turned over to the University of the Philippines, the Forest Products Institute.

Maria Cristina Chemical Industries is perhaps the largest user of charcoal for calcium carbide production and for that purpose, fine charcoal feed is undesirable. Briquetting of these fines would improve material yields and furnace efficiency. Because of this interest, I happened to visit the Forest Products Institute in 1962.

The Institute was eager to conduct experiments. They could not get materials at their place in Los Baños and charring scrap lumber from saw mills was a pitiful sight. It was not practical to ship our fines to Los Baños and ship back the briquettes. We came on a modus vivendi. We will dismantle, ship and install the whole plant at our Iligan plant site. We shall open all facilities including operating data on the application side to the Institute. At the end of the experiment, we shall dismantle, ship and reinstall in the original condition, the plant.

We worked for a year on a joint effort, fooling with all sorts of binders and dryers and one day, we stumbled on a unique formula using calcium carbide sweepings which made a good briquette which was self-drying. It did not need further drying. As far as we know, this formula for a binder has never before been used. As a result of this, we applied for and was granted a joint patent. This was Philippine Patent No. 2673 applied for on November 8, 1963 and granted on October 20, 1966. The title is "An Auto-drying Binder Composition and Processes for the Formulation of Same." The result of our one-year experiment with the Institute's technician is now published and is public property. The Institute is happy that something worthwhile came out of the pilot plant. We at Maria Cristina, ordered the equipment for commercial sized plant, based on the results of the patent we hold. This plant has been in full operation and today has been increased in capacity such that it could supply 40% of the feed of the carbide furnace if operated 24 hours a day at full load. We at MCCI are happy over the joint effort.

I am sure each industry group has similar problems and we do need the NSDB in most cases. Perhaps this workshop and the incoming tax money will open our eyes and that of the NSDB and with a good dialogue produce tangible results in a short time.

RESEARCH IN THE PHILIPPINE CEMENT INDUSTRY

BY AURELIO MONTINOLA, JR

The 1967-1968 yearbook of the Cement Association of the Philippines states, "A major function of the Association is research and compilation of data on cement and concrete technology for the benefit of the people in the industry. It also extends its facilities and services to all users of cement and concrete as a public service. Its mission to encourage research and disseminate information on how to improve on and extend the uses of cement and concrete is basic."

In an effort to realize this objective the Association has formed a Committee on Research and Development composed of able-minded scientists and technicians from the individual member companies. The Cement Association of the Philippines, however, is non-profit organization operated on a very modest scale from dues and assessments paid by its members. Scientific research, on the other hand, is expensive and results are understandably slow and unpredictable. It is therefore not surprising that the Association has not as yet acquired laboratory facilities with which to conduct basic research.

Despite these constraint, the Committee on Research and Development, and consequently the Association, has done admirably well from the cement industry's viewpoint. The existence of such a committee has minimized, if not totally eradicated, wasteful duplication of efforts in the research tasks of individual cement companies. The industry has realized that with the limited funds available for research to the Association and to its member companies the need to utilize these resources efficiently becomes paramount. This the Association and its Committee on Research and Development provide a central body for the industry through which research work and information are channeled.

Within such a framework, the various firms in the cement industry as well as the Association have undertaken research projects aimed at (1) improving the quality of our product, (2) decreasing its costs of production with the welfare of the consuming public in mind, (3) extending the uses of cement, (4) the development of new construction products, and (5) the discovery of new processes and techniques that will optimize utilization of local raw materials.

Product Quality Improvement

On the matter of product quality, the Association's Committee on Research and Development has formed a Department on Standard Specifications whose function is to coordinate with government agencies and private entities in the preparation and adoption of standard specifications of cement. Parallel to this Filipinas Cement and Republic are undertaking technical studies on the feasibility of adjusting standard methods of testing to conform to local condition by utilizing our local sand instead of the imported Ottawa sand. It is no secret to the industry that test methods are still based on foreign standards which recommend usage of materials and facilities from foreign sources.

Reduction of Production Costs

In an effort to reduce our costs of production with a view of passing off these savings to the consuming public, the Association has recently embarked on a series of economic and technical studies on pulp and paper for cement bags refractories for kilns and grinding balls for mills. It is the hope of the industry to have an integrated an operation as possible to realize this objective of cost reduction. These studies, if successful will also lessen the industry's dependence on foreign suppliers and help in the improvement of the country's balance of payments. The pulp and paper project alone which has reached the final stage in our studies is estimated to save for the country $2,500,000 worth of foreign exchange annually.

Individual companies have also contributed to this goal of cost reduction. To cite a few, in 1953 Rizal Cement has pioneered in the use of locally manufactured mill liners as well as in the use of locally made mill shell for clinker grinding. It has furthermore undertaken experiments that will find better ways of atonizing bunker fuel with a view on saving costs. Also, Marinduque Mining and Industrial Corporation, the producer of Island Cement, has suggested the manufacture of synthetic gypsum made from limestone and volcano crater lake water.

Expanding the Uses of Cement

To stimulate construction activities in the country, the industry seeks to expand the uses of cement. Republic has pioneered in research work on prestressed concrete culminating in the establishments of a separate organization manufacturing such products as bridge sections, piles and posts, beams precast and prestressed concrete floorings for high rise buildings. Rizal, on the other hand, is currently experimenting in the use of kiln dusts as fillers for other industries. The success of similar research efforts will ensure the cement industry of a steady market for its product.

Development of New Construction Products

Research in the Philippine Cement Industry is also geared towards the development of new products one of which is lightweight concrete aggregates. With its vast deposits of clay and shale, the industry is a logical producer of lightweight aggregates and intensive efforts are being made by various cement firms to come up with an acceptable product.

Development of New Processes and Improvement of Present Techniques

Certain adjustments of production techniques and processes have been affected by the industry. As an example, Republic Cement has applied for a patent covering the particular process that its research staff has developed for the production of lightweight aggregates. It has also introduced the dust bag collection system to abate air pollution in the community. This system consists of a large bag house containing suspended bags woven from glass fibers capable of resisting high temperatures. It has proven highly efficient in the elimination of stack gases and is most appropriate to its particular type of raw material which is characterized by low electrical conductivity.

Recommendations

You will note that the accomplishments mentioned above are more of the type emphasizing an immediate return on investment. Basic research such as those shown on Appendix "A" of this paper is unfortunately a field that has been untapped not so much by negligence but by lack of adequate resources needed to pursue them. Such work could be farmed out in the form of fellowships or grants in local universities on technical entities such as the National Institute of Science and Technology, the Bureau of Mines, or other similar organizations. Such a procedure has been employed by the Portland Cement Association of the United States which in spite of possessing about $10 million worth of research facilities in Skokie, Illinois, at one time established fellowships at the National Bureau of Standards in Washington, D.C. resulting in studies and papers on many important subjects of cement technology as partially listed in the said appendix.

Furthermore, the Cement Industry at present consumes approximately 140,000 tons of imported gypsum annually worth about $1.5 million. This amount may increase as more cement plants are built or expanded. It would be a worthwhile research project if a geological and drilling team could be financed or subsidized for the purpose of discovering and exploiting deposits of local gypsum of suitable grade in this country. This would not only conserve foreign exchange, but may also result in a reduction in the cost of cement. There are some known deposits of gypsum in Batangas, Negros, and Cebu. But insufficient studies have been made on these deposits to warrant their commercial development and exploitation.

In this connection, there might be some objection in some quarters to the inclusion of mineral prospecting as a part of research or industrial research as seems to be the general topic of this workshop. If mineral prospecting is not within the purview of the recently enacted tax measure that would raise approximately ₱50 million for the promotion of science, then we are neglecting a very important aspect of our economic development. No one can gainsay the fact that this country is very rich in natural resources and that many such resources remain still undiscovered, unsurveyed, and untapped. Gypsum, bauxite, tin, petroleum, and many other minerals and deposits would contribute greatly to the nation's economic advancement just as much as the results of industrial research. If mineral prospecting is not included in the recent Congressional tax measure for science, it certainly would be advisable for the Department of Agriculture and Natural Resources or for the Bureau of Mines to seek additional sources of funds for mineral exploration and geological work and studies.

Conclusion

What has been outlined before you are a few of the research accomplishments of the Cement Industry and some possible means of improving the status of cement research. It is our way of emphasizing the importance of research for a technically oriented industry like ours. In order to achieve stability for an industry on which thousands of people are dependent for their

livelihood, and which incidentally is racked by a period of oversupply, the need to lower costs, to integrate, and possibly to diversify becomes essential. To realize this goal we must have research. The Congressional Tax Measure for the development of science is therefore something we cannot disapprove of.

APPENDIX "A"

SCIENTIFIC INVESTIGATION OF THE PORTLAND CEMENT ASSOCIATION AT THE NATIONAL BUREAU OF STANDARDS (U.S.A.)

Paper No:

1. "Studies on the System CaO-Fe_2O_3 -SiO_2," by W. G. Hanson and R. H. Bogue.
2. "The Determination of Uncombined Lime in Portland Cement," by Wm. Leech and R. H. Bogue.
3. "A Digest of the Literature on the Constitution of Portland Clinker," by R H. Bogue.
4. "Portland Cement Research," by R. H. Bogue.
5. "The Preparation and Optical Properties of Calcium Hydroxide Crystals,'" by F. W. Ashton and Raymond Wilson.
6. "Studies on the System CaO-Al_2O_3 -SiO_2. The Composition $8CaO + Al_2O_3 + 2SiO_2$," by W. C. Hansen, W. Dyckerhoff, F. W. Ashton, R. H. Bogue.
7. "The Preparation of Optically Clear Selenium for Use in Index Media," by L. T. Brownmiller.
8. "X-Ray Diffraction Measurements on Some of the Pure Compounds of Portland Cement," by E. A. Harrington.
9. "Portland Cement in Concrete Engineering," by R. H. Bogue.
10. "The Combination of Lime in Portland Cement Compounds, Preliminary Investigation," by W. C. Hansen and R. H. Bogue.
11. "Studies on the Hydrolysis of Compounds Which May Occur in Portland Cement," by Wm. Leech and R. H. Bogue.
12. "Further Studies on Portland Cement Compounds by the X-Ray Diffraction Method," by W. C. Hansen.
13. "Studies on the System Calcium Oxide-Alumina-Ferric Oxide," by W. C. Hansen, L. T. Brownmiller, and R. H. Bogue.
14. "Equilibrium Studies on Alumina and Ferric Oxide and Combinations of These with Magnesia and Calcium Oxide," by W. C. Hansen and L. T. Brownmiller.
15. "A New Registering Photodensitometer," by E. A. Harrington.

16. "A Precision Method for Measuring Temperatures of Refractive Index Liquids on a Crystal Refractometer and on a Microscope Slide," by F. W. Ashton and W. C. Taylor.

17. "A Digest of the Literature on the Nature of the Setting and Hardening Processes in Portland Cement," by R. H. Bogue.

18. "Phase Equilibria in the System $2CaO.SiO_2$ -MgO $5CaO. \& {}_3Al_2O_6$," by W. C. Hansen.

19. "The Sulphoaluminates of Calcium," by Wm. Lerch, F. W. Ashton, and R. H. Bogue.

20. "The Cause of Unsoundness in Portland Cement," by Wm. Lerch.

21. "Calculation of Compounds in Portland Cement," by R. H. Bogue.

22. "The Influence of Magnesia, Ferric Oxide and Soda Upon the Temperature of Liquid Formation in Certain Portland Cement Mixtures," by W. C. Hansen.

23. "Revised Procedure for the Determination of Uncombined Lime in Portland Cement," by W. Lerch and R. H. Bogue.

ERRATA

1. Page 32 B. PHILIPPINES'S ECONOMIC GROWTH POTENTIAL AND NATURAL RESOURECS

   B. PHILIPPINES' ECONOMIC GROWTH POTENTIAL AND NATURAL RESOURCES

2. Page 37 "0.05%" should read 0.15%

3. Page 38 Enclosed in parenthesis (0.045 of total government budget in 1970)

4. Page 44 "researchers" should read researches

5. Page 44 *In the 4th paragragph, after the 7th line*
   (also produced from local materials, and "instant patis" and "instant toyo" more delicious than imported breakfast foods. Canned infant foods were processes also developed. These activities will be continued; and in the field of food science, emphasis will be given to the development of new food products from local sources.

   should read cereal, fortified with coconut flour, which was richer in protein content and more delicious than imported breakfast foods. Canned infant foods were also produced from local materials, and "instant patis" and "instant toyo" processes were also developed. These activities will be continued; and in the field of food science, emphasis will be given to the development of new food products from local sources.

6. Page 64 "1917" should read 1957

7. Page 65 "trustees" should read trusses

8. Page 70 "42,0000" should read 42,000

9. Page 88 "thievalopsis" should read thielaviopsis

10. Page 112 last line on this page should be deleted *gubas* (*Endospermum peltatum*)

11. Page 113 *gubas* (*Endospermum peltatum*) should be included in the listing of Researches of Insulation Board Materials

12. Page 114 "lanipan" should read lanipau

13. Page 118 *After the fourth line of the first paragraph*
   (established n the trial areas are as follows: 5.5-year old plot of 0.25-hectare con-cm, average diameter, 1.2 m. average height, and 0.01 cu. m. average volume taining 174 trees had 1.2 cms average diameter, 1.1 m. average height, and 0.001 cu. m. average volume per tree: a 9-year old plot of 40 trees had 1.7 per tree; a 10-year old plot of 0.231 hectare containing 113 trees had 1.8 cm. average diameter, 14 m. average height,)

   should read (established in the trial areas are as follows: a 5.5-year old plot of 0.25-hectare containing 174 trees had 1.2 cms. average diameter, 1.1 m. average height, and 0.001 cu. m. average volume per tree; a 9-year old plot of 40 trees had 1.7 cm. average diameter, 1.2 m. average height, and 0.01 cu. m. average volume per tree; a 10-year old plot of 0.231 hectare containing 113 trees had 1.8 cm. average diameter, 1.4 m. average height,)

14. Page 119 "tem" should read system

15. Page 124 After the word "developing" in the 8th line of the paragraph, add *countries*

16. Page 127 "elecerical" should read electrical