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TABLE OF CONTENTS

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CONSERVATION OF NATURAL RESOURCES: A VITAL ENVIRONMENTAL ISSUE IN THE PHILIPPINES

by

DOMINADOR Z. ROSELL, FELICIANO M. LAPID AND AURORA S. TOLENTINO

INTRODUCTION

The conservation of natural resources and the maintenance of environmental quality are the most important issues of the Republic of the Philippines today. The increasing population and its needs for existence with optimum quality and standard of living, the maintenance of our natural resources and the quality of our environment are most important issues to the country and people.

GEOGRAPHICAL FUNDAMENTALS

What are conservation, natural resources, and environment? These are the three most important items for exposition to bring forth the issues.

1. Conservation, as defined by Webster Dictionary, means the act of keeping or protecting from loss or injury. The dictionary further quotes W.H. Taft's speech on September 5, 1910 before the Conservation Congress in Saint Paul, Minn. as follows:

"Conservation as an economic and political term means the preservation of natural resources for economic use so as to secure the greatest goal for the greatest number."

This definition sounds too idealistic and unless further explained would only mean the keeping of the natural resources for somebody else. On the other hand, that definition established the subject for discussion which challenges others whose philosophies of life in this world are for the establishment of a better place to live in. The geographer, agricultural economist, and sociologist advanced their definitions . (1)

The geographer defines conservation as the wise utilization of natural resources for maximum benefits with minimum wastes. This also means

* President and Director, respectively, of the Philippine Geographical Society, and Planning Officer II, National Science and Technology Authority.

the employment of all faculties of good judgement for the efficient utilization of certain resources in question. The economist, on the other hand, defines conservation as "conservation in practice as in public policy is to increase the productivity of our natural resources and to heighten social values." Thus, conservation may be characterized as a prudent administration of the natural agents of production enforcing reasonable strain and efficient utilization in the appropriation of the natural resources of the earth, and when feasible, promoting their reclamations to the end that productive capacity shall be economically developed and maintained and the natural inheritance of the earth shall be improved. Following this trend of this definition, it seeks to provide for a well-balanced production and consumption of resources for indefinite time. (2)

In the Philippines, especially the Philippine Geographical Society, the National Committee on Geographical Sciences and the National Research Council of the Philippines (NRCP), the College of Arts and Sciences, U.P. and the Ministry of Natural Resources of the government have big stakes in the correct meaning and application of the word conservation. When we speak of conservation we are concerned with wise utilization of natural resources with minimum of waste, thus maintaining continuous existence of these resources.

EXPLOITATION VERSUS CONSERVATION OF NATURAL RESOURCES

To an engineer, exploitation is a perfectly respectable term meaning to develop for use and benefit. It comes from a word meaning to unfold. To the conservationist, it has an evil meaning; wrong, destructive and selfish use. Here is where the word exploitation differs from conservation, both economically and morally. Conservation as applied to land and other resources means wise use. (3)

To illustrate — let us consider the natural drainage arteries of an urban area. In the city of Manila we call these drainage arteries "esteros" of which there are quite a number in downtown Manila. For conservation of these esteros, we clean and dredge as often as possible to keep the rain water flow freely and avoid flood during the rainy season of the year. Other people, however, especially the affluent and the capitalists or oligarchs exploited these channels by constructing commercial and business structures and houses on these esteros, thus obstructing the flow of water. Moreover, squatter's shanties built along estero banks plus the uncontrolled dumping of household garbage into these esteros or canals gravely deteriorate water flow. Continuous rain for days or even for hours easily produce serious flooding all over the low areas.

2. Natural resources are elements of the natural environment upon which man derives his livelihood and well being. These are land and soil, flora and fauna, minerals under the land and soil, water on land, underground water, rivers, lakes and seas, the rays and heat of the sun,

weather and climate. From these natural resources, man makes his living, enjoys life until he dies. Our existence depends upon how we utilize these resources and live and enjoy their blessing or suffer from their scarcity. It is therefore essential that we utilize them properly and wisely and thus maintain their utility for the benefit of generations after generations.

Beside the natural resources, there are also other resources, such as the human resources that consist of man and his talents, and also cultural resources whereby people enjoy the blessings of technology, education and governmental system. These two other resources will not be discussed in this exposition of conservation of natural resources and maintenance of environmental quality.

NATURAL RESOURCES AND THEIR CONSERVATION

The Philippines is rich in natural and earth resources. The total soil cover is 300,000 square kilometers or 30 million hectares. The mountains, hills, and rolling lands are replete with vegetations, of forest trees and grasses, of wildlife and comparatively rich in minerals and mineral fuels. The forest cover as of 1972 constituted 52.24 percent while the non-forest land was 47.76 percent or 14 million hectares. There are 15 principal metallic and 20 non-metallic minerals in 25 million hectares of geologically surveyed land.

The territorial water is composed of 180 million hectares with 2,200 known species of fish with mollusk life known to be the most abundant.

The land form or topography is generally mountainous, hilly, rolling to level. In 1956, the total area for agricultural production was estimated at 20 percent or six million hectares.

The climate provides abundant rainfall and sunshine giving the whole country twelve months of growing season in the year. Rice and corn can be planted the year round and where irrigation is available, rice crop is grown in three crops in one year. (4)

"The wants of people must be met out of the land or go unsatisfied. Of course, different groups of people want different things at any time. And the wants of individual groups change over periods of time. Conservation insist that the land and other natural resources must be used for supplying present wants and maintained in conditions to supply future wants."

CONCEPTS OF NATURAL RESOURCES CONSERVATION

Professor Behan, in his exposition of the "Litany of Scarcity versus the Challenge of Abundance", presented provoking expositions that lead to various resources. (5) In the book Natural Resources Conservation, An Ecological Approach, its introduction has this to say, and we quote:

"America is on the sharp edge of crisis (1973). She is degrading her natural environment. She prides herself on conquering outer space, yet after two centuries, she still does not know how to manage her "inner" space on earth. This environmental dilemma is the result of four major factors, namely: rapid population increase, pollution, excessive consumption of resources and the gradual deterioration of land ethics," unquote.

Professor Behan further said, "We all know that natural resources are fixed and finite. There is just so much, quantitatively of our stock resources of iron ore, petroleum, sulfur, etc. And there is a fixed limit on how much we can grow of the renewable resources — timber, forage, and wildlife. Natural resources are fixed and/or limited." It is on this basis that he called this **inventory concept of natural resources conservation.**

The other concepts of natural resources conservation that are discussed in this exposition are: (1) Functional Concept, (2) Multiple Purpose Use Concept, (3) Watershed Concept of Water Conservation, and (4) Environmental Concept.

1. **Inventory Concept** — The utilization of our forest resources within the context of inventory concept has been going on year after year especially after the World War II when the Philippines went into massive reconstruction programs of the economy. With the help of the US dollars and army surplus equipment such as trucks, bulldozers and such other heavy equipment for road construction, Mindanao, rich in forest resources, was the first victim to the unrestricted exploitation.

Conservation of the forest resources within the context of inventory concept, demands that while these resources are being utilized, provision for future use by the next generations must be programmed. As a tree is cut down for logs and lumber, seedlings of trees must be planted to replace the trees cut and other trees destroyed during the operation. Logged-over areas must be planted either with fast growing soft-wood trees that can be harvested in 8-16 years or with other dipterocarp species for a long term period. In this way, deforestation of forest areas will be avoided and therefore, kept evergreen for generations.

In our country, the only logging and forest concessionaires practicing forest conservation we know are the Nasipit Lumber Company and the Aras-Asan Lumber, Inc. This concept of conservation of natural resources especially forest resources, if followed strictly, will provide our children and grandchildren with forest vegetation, quality watersheds and refreshing climate for all time.

2. **Functional Concept** — The conservation of natural resources within the context of functional concept makes use of technology, as the important component of conservation. In this concept, a resource is more than just a tangible, physical substance. A resource is also defined by the utility we perceived in the substance and by the technology

of transforming the potential of the substance into the actuality of satisfaction. The equation to express this concept is:

$$R = f\ (UsT)$$

Within this concept therefore, a resource (R) is equal to the function (F) times the utility (U) of substance (s) and of technology (T). The substance, for all practical purposes and to orthodox minds is indeed fixed and finite. But the utility factor and the technology factor are not limited at all. We find new ways for and new ways to use many substances all the time, and for old substances, too. The logical conclusion here is as simple as it may be startling; Natural resources as functions rather than inventories are not a bit limited. (6)

In the Philippines, we find this concept very practical, effective and constructive. After the great flood in Central Luzon in July 1972, forest concessionaries of the whole country were given new directive in logging operations. Only those concessionaries who have equipment and machineries to process the logs into finished lumber and who can use the waste material in logging operation into usable products like wallboards called "lawanit" and similar products, were allowed to continue to operate their concessions. These directives removed the operators whose aims are to exploit the forest resources for fast dollars and denude the hills and mountains of forest trees. Their concept of development of our economy is to increase exportation of logs and increase the dollar income without thinking of future conditions of the forest resources for the next generations. This is really exploitation of the first degree and not conservation.

3. **Multiple Purpose Use Concept** — The conservation or the wise utilization of natural resources within the context of multiple purpose use concept takes advantage of some of the components of the functional concept. Here, technology goes one or two stages farther than the usual transformation of the substance into the actuality of satisfaction.

This concept is being applied more and more on forest and range lands, in watersheds, on water impoundments and water courses. As recreation use soars, there is a greater need to protect the many fragile scenic and aesthetic areas. Conservation has known and applied the skills and technology necessary to safeguard and improve our resource base. (7)

A good illustration of multi-purpose use concept is the conservation of water. Water, a natural resource, can be utilized to serve many purposes to satisfy human wants. This is besides its use directly for human consumption. Such water uses are recreational, for fishery, irrigation, and water power, all in one system. This is exemplified in our Upper Pampanga River Project (UPRP) of the National Irrigation Administration (NIA) of the Republic of the Philippines. Completed at the cost of about 1 billion pesos, the project irrigates about 770 square

kilometers of rice lands during the wet season and about 729 square kilometers of rice lands during the dry season with an annual production of more or less 570,000 metric tons of rice. The water supply of 2.5 billion gallons (1 gal. = 3.79 liters) in this project can generate 100,000 KW of hydroelectric power. Besides controlling floods, the project also provides the medium for the production of fish, and promotes local ecological balance, and in a way, promotes tourism in the region. Here is a water resource conservation practice illustrating the multiple-purpose use concept.

4. Watershed Concept of Water Conservation — Water is an important element of nature and of the human body. As a constituent element of our environment, water is indispensable to all living organisms. Whatever water we have, we must protect it from being polluted or its disappearance in our land. Its relation to land is that 71.7 per cent of planet earth's surface is water and 28.3 percent land. According to the data produced by the International Hydrologic Decade, the total volume of water of this planet is 326,076,000 cubic miles, broken down as follows:

1.	In the ocean		317,000,000 cu. mile
2.	On the surface		
	river and streams	3,000 cu. mile	
	fresh water lakes	30,000 cu. mile	
	salt lakes and inland seas	25,000 cu. mile	
3.	Underground water		
	soil and moisture seepage	16,000 cu. mile	
	ground water 1/2 mile deep	1,000 cu. mile	
	ground water 1/2 mile deeper	1,000 cu. mile	
			76,000 cu. mile
4.	Glacier and ice cap.		9,000,000 cu. mile
	Grand total		326,076,000 cu. mile

1 cubic mile of water = 1,101,117,143,000 gallons
= 4.16×10^9 cu. meters

The distribution of water of the world and the amount any country has depends upon many factors, such as climate, soil, topography of the land, natural flora and fauna, and the location and space on the surface of the globe. The Philippines and the countries in South-east Asia are within the torrid zones, north and south of the equator; rainfall is abundant and temperature is warm and hot. As part of the monsoon region of Asia, the rainy season is influenced by the monsoon winds. Torrential rains come sometimes by nine continuous days at a time.

Water conservation, aided by properly constructed water facilities, will go a long way in the maintenance of the environmental quality. Floods in Central Luzon always occur during the rainy season of the year. This destroys rice and corn crops besides houses along the water-

ways such as rivers and canals. One of the solutions would be the construction of catchment basin big enough to accumulate all running water that come from the watersheds. To illustrate; we may construct a basin as big as eight kilometer long, five kilometer wide, and ten meter deep in the Candaba swamp area. This does not need concrete wall since the excavation will create a natural basin big enough to accommodate 400 million cubic meters of water. (The senior author had thought of this concept when he was Administrator of the Irrigation Service Unit, Department of Public Works and Communication in 1952-1960).

5. **Environmental Concept** — To the conservationist, this concept has several implications. To the bird watcher, it is the protection of the bird sanctuaries. To the hunter, it is the preservation and increase of game in the hunting ground. And to the naturalist, it is living in harmony with nature. About the only group of people who came close to doing this were the American Indians of the early days.

The utilization of natural resources within the context of environmental concept is well exemplified by the projects of the Parks and Wildlife Office of the Ministry of Natural Resources, Republic of the Philippines. This concept unfortunately is not well known by the public because it is being taken for granted.

However, in the case of the famous Rizal Park in Manila, you find the concept being applied and fully appreciated by thousands of people. Trees are planted and grown not for the logs or pulp they produce but for the shade and the beauty the trees impart to the whole park complex. A hill was constructed to simulate a waterfall for the park visitor to see and admire; a long pool of water and fountain create a make-believe wilderness.

Animals of local and foreign species are kept in well constructed cages for the park visitors to see, appreciate and venture into the study of their existence and origin. Flowers of different varieties are planted and grown not to be pick-up but to be admired by the park visitors.

The environmental concept can be considered as the result also of the application of the combination of the inventory concept, the functional concept and the multi-purpose concept of natural resource conservation.

In totality, the geographer, as a generalist, makes use of a variety of disciplines to achieve man's desire in the satisfaction of human wants. His concern for the future generations makes him a citizezn of the world, not only of an individual country. If man really learns and understands that natural resources are not infinite, he may yet be able to live in harmony with his planet and at the same time protects the natural resources, utilizes them wisely throughout his life and maintains their existence and using them wisely and sees that they are there and keep the environment for generation and generations as nature makes them.

It is obvious therefore, that the most urgent need is to find some ways of making conservation education into a law for the young and old, to see that the future is still there as good if not better. The law should be instructional, with study and discussion of current problems and needs in the conservation of natural resources; include but not limited to air pollution, water pollution, the effects of excessive use of pesticides, the conservation of wilderness, forest management and the protection of wildlife and humane care of domestic animals, wise use of soil and water, timberlands, forests, minerals, fish and other aquatic life and the scenic and recreational resources.

If we can really bring this idea of education on the conservation of our natural resources by Congressional Law to educate on our people young and old, we will be doing a good deed to our generation by conservation (wise utilization) of our natural resources and at the same time keep our environment as clean as nature has give us.

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NATIONAL PLANNING ATLAS OF THE PHILIPPINES A PROJECT PROPOSAL

by

DIRK BRONGER*

Relevance and Significance of the Project for Regional Development Planning and Policy (Explanatory Note)

A Planning Atlas is to be considered as a special type of a National and Regional Atlas. It is not their task to function as a mere "cartographic survey" of a certain country/region but to analyse the problems of development and the development targets of the country/region concerned. As these problems and targets are first of all dependent from its natural resources in conjunction with its population and economic structure, a planning atlas also has to originate from these factors. Therefore the first part of the proposed "NATIONAL PLANNING ATLAS OF THE PHILIPPINES", i.e., Part I: The ENVIRONMENT, serves this purpose of an information and, at the same time, causal character.

The main function of a Planning Atlas is, above all, to work out where (and why) structural detriments or even damages have occurred, how they can be corrected, which tendencies should be promoted or prevented in the future and which measures could be and should be taken up to realize the idea and of a balanced (structurally as well as functionally) region and thus of the country as a whole. The selection of the subjects and their presentation as well as interpretation through the maps are therefore determined to the targets of development as well as the aims of spatial organization.

In characterizing the quite complex development problems concerning the Philippines a — mostly overlooked — spatial aspect should be considered as very essential: the existence of pronounced regional disparities in economic as well as in social and cultural respect within the country leading to the co-existence of quite a number of different stages or levels of development.

More precisely these dualisms find their spatial expression especially in three phenomena, which are again closely interlinked with each other:

* Dr. Dirk Bronger is Professor of Georaphy, Ruhr-University of Bochum, West Germany; Visiting Professor (1975-1979) at the Department of Geology and Geography, University of the Philippines, Quezon City, Philippines.

1. A pronounced **metropolization**: only a single outstripping center, i.e., the capital respectively the capital region ("Metro Manila") has emerged. In other words: in many aspects only a **punctuate** development has taken place which has been restricted first and foremost to the capital region.

2. This means compared to the "core region" nearly all other parts of the whole country are to be characterized as "underdeveloped". In respect of an efficient spatially based development planning and development policy, as important are the **existing pronounced differences with regard to the level of development within all the other so-called peripheral regions.**

   Precisely the consequences of the phenomena of these dualisms and their combined effects are making these aspects the most significant criterion of the country, i.e., the steadily increasing internal rural-urban migration mainly into the capital region, the emergence and expansion of slum and squatter areas with the following threat to mainly social unrest up to the endangered existence of the state as a political unit.

3. All these consequences cause an **increasing effect of the two** phenomena in a negative sense: firstly it concerns especially during the past 30-40 years the steadily growing process of metropolization restricted almost solely to the capital region, and secondly the increasing gap of the level of development between the capital region and the peripheral regions on one side as well as within the peripheral regions on the other.

These connected facts, the national primacy and the interregional disparity, which both show a steady growth make it necessary or, what is more essential to develop and to implement a strategy which aims two-fold: Firstly to transform the existing spatial structure from a monocentric into a polycentric one (in which of course one center remains as the first!) in order to slow down and counterbalance the rapid and one-sided development of the capital region. Secondly not only to stop but in the course of mid-term regional planning to reduce the existing and still increasing regional disparities in spatial as well as in functional terms in order to overcome these dualisms in the future.

Out of these facts the main target of the planning atlas is to be deduced: this task consists in the necessity to work out and present cartographically spatially differentiated analyses of the level of development concerning the individual regions (provinces) of the Philippines including the structural and functional analysis of the regional centers as the crystallization points of development within the rural areas. Only the detailed knowledge of the stage and the potential of development of the single regions and the regional centers as well verified as much as possible by quantitative data, and, finally, including the casual connec-

tions of the so much different level of development form the **precondition** which enables the regional planner and politician to derive concrete measures from the results and realize them in practice. To put it more precisely: any development planning which aims first and foremost in reducing the regional disparities is not conceivable without such analyses.

In accordance with these main thoughts which could be discussed only very briefly within this context, the contents of the major part of the atlas (Part II: Aspects of Planning) is to be drafted as follows:

1. determination of the **stage of development of the individual regions** (i.e., at the present — 1980 existing 74 provinces) of the country.
2. analysis of the **hierarchy of the regional centers** including their spatial organization and their functionally attached areas.
3. out of these results we can deduce which of the individual regions belongs together in respect of their functional inter-dependencies; i.e., to work out a **functional based regionalization** of the country into 15 **planning regions.**

The implementation of such a plan which aims at the undoubtedly pretentious objective of an as much as possible solid investigation of the level of development of the individual regions together which the determination of the spatial organization of the regional centers as a decision basis for a regional planning and policy, is based on the following **methodological** reflections:

1. Because of the complex interpretation of our central term "stage (level) of development", as far as possible all fundamental **vital functions** ("determinants") should be covered by indicators.
2. As **development potential** as well as **development process** are to be considered as essential causal factors for the **understanding** of the present level of development and also as decision basis of the selection of the regional centers the single indicators ("development factors") to be used should be diversified as much as possible.
3. In order to get valuable results regarding the essential aspect of the **dynamics** of the development process it is necessary to use **sequences of data** for an as much as possible far reaching period of time for all essential causal factors.
4. To determine the regional disparities the selection of the spatial units should be as much differentiated as justifiable. Since the single regions (provinces) naturally differs very much in size as well as in population the figures should not be taken absolutely but counted by area or by capita respectively.
5. In this connection we have to state also the necessity to take qualitative data as a basis for such a solid study. Also for the

Philippines it is characteristic that their economic as well as social and cultural institutions vary much in size.

As far as the cartographic presentation as well as its interpretation is concerned another fundamental methodological problem of weighting the single indicators is to be solved. To find an as much as possible satisfactory solution the main vital functions (Area and Population and Administration: Economy; Transport and Communications; Education and Health; Living and Housing) should be represented each with the same number of indicators. In order to get also a quantitative comparability of the development factors the interpretation of the data could be done either by factor analysis or they should be transformed into a scoring system: the maximum obtainable score for a development factor will be 100 points and the score for the remaining data has to be proportionally computed.

To sum up we can state: only a comprehensive analysis of all the leading development factors obtained will give us the necessary perceptions:

1. to take up effective measures in order to improve the structure of the less developed individual regions in respect of our main strategy to reduce the pronounced regional disparities within the country.
2. as it is difficult if not impossible to develop all peripheral regions equally to the same extent and intensity at the same time the findings of such a compresensive study gives us the possibility to determine out of the total number of the regions the definitive selection of the "action regions" defined as those regions which should have the top priority for development.
3. to develop and to implement a strategy of a balanced hierarchical set of regional development centers in order to reduce the overwhelming dominance of the capital region.

As far as the interpretation of the individual results as well as the analysis of the strategies regarding the regional development of the country are concerned detailed text forms an integral part of the atlas.

PART I: THE ENVIRONMENT

1. Natural Resources

Plate No. 1 Philippine's Environmental Location
2 Relief
3 Slope Map
4 Tectonic Structure
5 Geology
6 Geomorphology (Landforms)
7 Soils

8 Temperature (1951-1980)
9 Annual Normal Relative Humidity (%) 1951-1980
10 Annual Rainfall 1951-1980 and Principal Weather Stations
11 Monthly Rainfall and Seasonal Storm-Tracks 1951-1980
12 Climatic Regions
13 Vegetation
14 Land Utilization

2. Human Resources

Plate No. 1 Administrative Division 1980
2 Administrative Divisions 1903-1980
3 Population Distribution 1980 and Classification of Towns/Cities
4- 5 Population Density 1903-1918-1939-1948-1960-1970-1970-1980 (8 maps)
6 Population Growth 1903-1948; 1948-1980; 1903-1980 (3 maps)
7 Settlement Structure: Urban-Rural Population 1948-1960-1970-1980 (4 maps)
8 Migration 1948-1960; 1960-1970; 1970-1980; 1948-1980 (4 maps)
9 Literacy Rate of Population (10 years old and over) 1980
10 Major Languages
11 Major Ethnic Groups
12 Major Religious Groups
13-14 Distribution of Education Institution — by Level 1980
Primary, Intermediate, Secondary;
Vocational; Colleges, Universities
15-16 Enrolment of Educational Institutions 1980
Primary, Intermediate, Secondary;
Vocational; Colleges, Universities
17 No. of Hospital Beds by Type per 1000 population 1980
18 No. of Medical Staff by Type per 1000 population 1980
19-20 Economically Active Population in: 1960-1980
Agriculture, Hunting, Forestry and Fishing
Mining and Quarrying
Manufacturing
Electricity, Gas, Water and Sanitary Services
Construction
Commerce
Transport, Communication and Storage Services

3. Economic Resources

Plate No. 1 Land Tenure — 1980 (4 maps)
Farms — Number by Size and Province

Farms — Area by Size and Province
Farms — Number by Tenure of Operator and by Province

2 Irrigation — 1980

3- 4 Crops — 1980
Foodcrops
Cash Crops
>8 maps

5 Cropland — Distribution by Major Crops and by Province 1960 & 1980 (2 maps)

6 Agricultural Land Use — 1980

7 Fertilizers/Pesticides used — 1980 (2 maps)

8 Value of Agricultural Production by Major Crops 1960 & 1980 (2 maps)

9 Livestock — 1980

10 Agricultural Infrastructure and Services (Rural Banks & Agricultural Vocational Schools, etc.) 1980

11 Fisheries — 1980 (2 maps)
Quantity of Fish Produced by Source of Production
Quantity of Fish Landed by Commercial Vessels

12 Forestry — 1980 (3 maps)
Forest Areas 1948 & 1980
Log Production 1980

13-14 Mineral Resources — 1980
Major Mineral Resources: Metallics
Major Mineral Resources: Non-Metallics
>2 maps
Value of Mineral Production: Metallics
Value of Mineral Production: Non-Metallics
>2 maps

15 Regional Distribution of Industrial Establishments by Size and by Province 1961-1967-1975-1981 (4 maps)

16 Regional Distribution of Employment in the Industrial Sector by Size and by Province 1961-1967-1975-1981 (4 maps)

17 Value of Industrial Production by Size and by Province — 1961-1967-1975-1981 (4 maps)

18 Industrial Employment Ratio per 1000 Population and by Province — 1961-1967-1975-1981 (4 maps)

19 Regional Employment Distribution according to Industry Group by Province — 1981

20 Industrial Employment according to Industry Group in Cities/Municipalities — 1961-1981 (2 maps)

21 Industrial Employment according to Industry Group in Metro Manila — 1961-1981 (2 maps)

22 Regional Distribution of Employment in the Cottage Industry Sector by Industry Group and by Province — 1981

23-25 Electric Energy
- Electric Grid 1961 & 1981 (2 maps)
- Status of Electrification by Households and by Provinces — 1961 & 1981 (2 maps)
- Power Consumption/Capita by Province

26-27 Transportation 1980
- Road and Rail Traffic
- Traffic by Air and Sea

28 Motor Vehicles per 1000 Population by Province 1980

29-30 Telecommunication 1980
- Regional Distribution of Telephone Sets and Telegraph Stations and Radio Broadcast Stations by Province
- Number of Telephone Sets by 1000 Population and by Province

31 Number of Banking Institutions by Type and by Province

32 External Trade 1950-1970-1980 (4 maps)

33 Leading Tourist Areas and Major Tourist Attractions

34 Tourist Accomodations (Bed Capacity) by Category and by City/Municipality

PART II: ASPECTS OF PLANNING

1. Regional Disparities

[Maps according to a scoring system — see explanatory text.]

AREA AND POPULATION

Plate No. 1 Population Density (persons/sqkm) 1980

2 Population Growth (2 maps)
- 1903-1948
- 1948-1980

3 Internal Migration (2 maps)
- 1939-1960
- 1960-1980

4 Arable Land/Capita
Cultivated Land/Capita (2 maps)

ECONOMIC CHARACTERISTICS

5 Income/Capita (2 maps)
- 1960
- 1980

6 Income Distribution: Proportion of Low Income Families to Household Population — 1980

7 Government Revenue/Capita
1960
1980 (2 maps)

8 Power Consumption/Capita (2 maps)
1960
1980

9 Secondary and Tertiary Sector Employment (%)
1960 (2 maps)
1980

10 Private and Government Capital Investments 1960-1980*

MANUFACTURING

11 Employment in Cottage Industries/Capita (2 maps)
1960
1980

12 Industrial Employment/Capita (2 maps)
1961
1981

13 Total Receipts (Industry)/Capita (2 maps)
1961
1981

AGRICULTURE

14 Area Irrigated/Capita (2 maps)
1960
1980

15 Fertilizers Used/ha (2 maps)
1960
1980

16 Value of Crops Produced/ha (2 maps)
1960
1980

17 Value of Fish Produced/Capita (2 maps)
1960
1980

TRANSPORT AND COMMUNICATION AND TOURISM

18 Hard-Surfaced Road Kilometerages/sqkm (2 maps)
1960
1980

19 Number of Registered Cars and Trucks/Capita (2 maps)
1960
1980

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* if available the "Net Domestic Product" has to be included (for 1960 and 1980).

20 Telephone Connections/Capita (2 maps)
1960
1980

21 Hotel Accommodation (Bed Capacity — First Category)/Capita (2 maps)
1960
1980

EDUCATION AND LIVING

22 University Students/Capita (2 maps)
1960
1980

23 Vocational School Students/Capita (2 maps)
1960
1980

24 Hospital Bed Capacity/Capita (2 maps)
1960
1980

25 Medical Care (No. of Doctors)/Capita (2 maps)
1960
1980

2. Regional Center-Hierarchy (Functional Structure I)
[maps according to a scoring system — see explanatory text.]

POPULATION AND ADMINISTRATION

Plate No. 1 Population 1980
2 Population Growth (2 maps)
1903-1948
1948-1980
3 Urban Population (%) 1980
4 Secondary and Tertiary Sector Employment (%) 1980
5 No. of Regional Offices and Provincial Headquarter 1980
6 Migration (2 maps)
1939-1960
1960-1980

ECONOMIC CHARACTERISTICS

7 Income 1960; 1980 (2 maps)
8 Government Revenue 1960; 1980 (2 maps)
9 Power Consumption 1960; 1980 (2 maps)
10 Industrial Employment 1961; 1981 (2 maps)
11 Technical and Vocational Schools 1960; 1980 (2 maps)
12 Banking Institutions 1960; 1980 (2 maps)

TRANSPORT AND COMMUNICATION

13 Registered Cars and Trucks 1960; 1980 (2 maps)
14 Air Passengers 1960; 1980 (2 maps)
15 Railway Goods 1960; 1980 (2 maps)
16 Coastwise Shipping Passengers 1960; 1980
Coastwise Shipping Goods (Value) 1960; 1980
17 Telephone Connections 1960; 1980 (2 maps)
18 TV Stations 1960; 1980 (2 maps)

EDUCATION AND LIVING AND HOUSING

19 University Students 1960; 1980 (2 maps)
20 Hospital Bed Capacity 1960; 1980 (2 maps)
21 Hotel Bed Capacity (1. Category) 1960; 1980 (2 maps)
22 Households with Electricity 1960; 1980 (2 maps)
23 Households with Piped Water 1960; 1980 (2 maps)
24 Households with Flush/Water Sealed Toilet 1960; 1980 (2 maps)

25-27 HIERARCHY OF REGIONAL DEVELOPMENT CENTERS 1900-1948-1980

28 ff. FUNCTIONAL INTERDEPENDENCIES OF THE MAJOR REGIONAL CENTERS

Catchment Area of:

Major Industrial Establishments
Universities
Colleges
Technical and Vocational Schools
Major Hospitals
Radio Stations
TV Stations
> of the Major Regional Centers

Supply and Sales Interdependencies (Regional and Supra-Regional) of the Major Agricultural and Industrial Products

HOUSING

29 Percentage of Households with Pipe Water Supply
1960
1980 (2 maps)

30 Percentage of Households with Flush/Water Sealed Toilet
1960
1980 (2 maps)

31 Percentage of Households with Electricity
1960
1980 (2 maps)

32 TV Sets/Capita
1960
1980 (2 maps)

33 Leading Development Areas — 1980

3. Regionalizations (Functional Structure II)

Plate No. 1 Regional Delineations 1947-1969 (4 maps)
2 Physical Planning Strategy for the Philippines: Regional Delineation Alternatives (3 maps)
3 Geographical Regionalizations (1942-1974; 4 maps)
4 Regional Delineations in the Seventies (1972-1977; 4 maps)
5 Present Alternatives (2 maps)
6 Regional Delineations of Manila Bay Metropolitan Region (MBMR) (4 maps)
7 MBMR: Regional Delineation Alternatives (2 maps)
8-13 Regionalizations of Metropolitan Manila (1960-1976; 24 maps*)
14 MMA: Regional Delineation Alternatives (2 maps)

* could be reduced to the most important ones.

A DESTRUCTIVE FORCE MORE TERRIFYING THAN A MILLION H-BOMBS

by

BRIG. GEN. GUILLERMO A. PECACHE*

"...Within a few centuries, the population density will be one person per square foot and we will have eaten our way down through the granite and basal beneath our feet. We will have literally consumed the earth and there will be nothing left for humanity except to devour itself."[1] — William Vogt

* * *

The title of this study is "The Ecological Time-Bomb." What is this frightful calamity which is more destructive than all the atomic-bombs and H-bombs being stockpiled by the super military powers of the world? The answer is simple: **people**. Following the biblical injunction, "Go ye, and multiply," people simply have not stopped multiplying since the dawn of history. Famine, wars, diseases, infanticide, birth control and contraception and natural calamities have not stopped human beings from proliferating and straining the finite resources of earth. This prompted the noted ecologist and population control expert, William Vogt, to state that "if population had grown since the beginning of the Christian Era (or 1 A.D., about two thousand years ago), at the rate it has increased during the past hundred years, then for every human being now on the face of the earth, there would be a million more? New York alone would not have eight million, nor eight billion, but eight trillion, or nearly three thousand times as many as inhabit the whole world today."

This may sound ironic for all the existing animal species on earth, man is the least prolific. A mature woman can only produce one offspring a year (except in cases of multiple births). In comparison a mother shrimp, during the spawning season, produces three batches of eggs numbering 1.8 million eggs.[2] It is estimated that if there is no mortality among baby shrimps, the oceans will become solid with trillions and trillions of this edible marine denizen. It is the same thing with oysters, salmons, anchovies, mussels, herrings, sardines, etc. On land, insects

* Commissioner, National Pollution Control Commission.

[1] Vogt, William, *PEOPLE!* Bartholomew House, Inc., New York, 1961.

[2] D'Aulaire, Emily: *Sumptuous, Scrumptious Shrimp.* The Readers' Digest, Nov. 1951, pp. 83.

reproduce by tens of thousands. It is a common knowledge how locusts, honeybees, flies, mosquitoes, aphids, bugs, ticks and other insects literally proliferate themselves into swarming millions in a short time. In fact, all egg-laying creatures are prolific breeders. The common hen can lay more than 200 eggs a year. If the earth is devoid of other forms of life and there are no predators and diseases for chicken in any form, a single mother hen can virtually start an avalanch of chicken that will fill the world from pole to pole in a century.

The near destruction of the agricultural continent of Australia a few centuries back because of the proliferation of rabbits is a storybook example of how a trifling incident can well decide the future of nations and people.[3] All domestic rabbits are descendants of the European rabbit, a mammal that has been developed for its size and meat. The rabbit is almost like a human being in its breeding habit which under favorable conditions last the whole year round. A rabbit may, unlike people however, have several litters a year. And unlike human beings, a female rabbit may have as many as five to nine litters, or an average of seven per birth. Left alone, a pair of rabbits can literally over-crowd the earth in a few centuries.

This was dramatically exemplified in Australia. Rabbits were introduced into England probably by the minions of Julius Caesar during the early days of the Roman empire. When the great island continent of Australia was discovered by Captain Cook and colonized by the British, some of the settlers in the new land brought with them domesticated rabbits for the family pot. These rabbits were fenced in rabbit pens one of which was accidentally swept away by a flood. Some of the rabbits escaped into the wilderness and bred so rapidly that they became Australia's number one agricultural pests. The major staple of the rabbit is grass, and other forms of leafy vegetation. Australia is considered one of the biggest countries of the world with endless grasslands, plains and forests and jungles. And some of the world's great deserts as well, no doubt in many places aggravated by the presence of the proliferation rabbits. Many biologists and ecologists have advanced the view that if the wild rabbits of Australia for which the term, "multiplying like rabbits" had been coined, had not been checked, they could have turned the vast virgin continent into a waste-land of arid sand dumes and lifeless deserts. In their vast uncounted numbers, the rabbits could have devoured every growing plants in their path. Bereft of food at last they would die and vanish like an evil memory. But their job of destruction shall have been done. Rain, flood waters, floods, landslides and wind action would have hastened the process of erosion. And Australia could have become dead continent.

But this is now how things worked. The environment has natural checks against anymore form of life which threatens the delicate balance

[3] Collier's Encyclopedia, *Rabbit*, Volume 19, pp. 580.

and the biotic factors necessary for survival of each species of living things including plants. And of course, men have also artificial methods of restoring ecological balance. When the rabbits of Australia became a threatening force, the people swung into action. They fenced their crop lands and vegetable fields to protect them from the raiding rodents as well as to deprive the rabbits of their food supply, thereby starving them off. Traps, poisoned food and other exterminating devices where launched against the rodents. Bounty hunters were set loose in the same way in which during the 1950's, in this country cash prizes were given to anyone who could turn in rats' tails particularly in ricelands badly infested by these rodents.

There was also noted a rapid increase in the population of the natural predators of rabbits such as owls, eagles, hawks, foxes and other flesh-eating mammals of the cat family. In areas where the vegetation had been badly thinned by the rabbits, the rabbit population began to drop because of lack of food from the natural surrounding. At any rate, the rabbit menace is still serious today in the interior of Australia. As in the case of the Australia rabbits, outraged nature has immutable laws to be used against the transgressors of the environment. Although to our imagination the laws of nature are almost moral in nature, they are actually physical and mechanical laws without which the earth and the whole universe would be chaotic, disoriented, illogical. These are the same laws that keep the stars and galaxies in their orbits and make possible the life and death of planets and starry systems. These are the old, old laws of compensation, equilibrium, symbiosis, action and opposite reaction, etc.

So rabbits do not really and could not simply multiply beyond the carrying capacity of the environment. Nor can shrimps or ducks or starfishes or snakes or elephants or whales. In many ways than we can imagine, many species of animals are more superior than man. Some of them can run faster. Others have larger teeth. Some of them can breath underwater. Some can fly. Some have eyesight a thousand times more acute than man's. Some have thick hides and armor to protect them from tearing fangs and claws. Others have wool to protect them from cold. The bloodhound, for instance, has a sense of smell a million times more acute than man's. And thousands of them have a capacity to produce more offsprings during a breeding season. But not one of them has been given the power to become the dominant species. Only man has that power. And because of the power to dominate not only all forms of life on earth but the environment as well, their number enormously increased, until their unstoppable growth has become the number one problem of mankind. There are many major problems of

course, like energy, food, housing, wars of liberation, employment, livelihood, education, urban decay and so on, but at the head of the list and underlying all other problems is simply the galloping population of the world.

Many writers have often likened the planet earth to a spacecraft or a boat. This comparison is not merely a heady flight of the imagination. As a symbolism, it has a practical aspect. A Spacecraft or a vessel presupposes passenger, that is, a specific number of human passengers. If a boat requires only one hundred passengers and a foolish captain loads it with one thousand passengers, the boat will sink. Today, the spacecraft earth voyaging through space is in danger of foundering because it has taken more passengers than its carrying capacity.

Nathaniel P. Reed[4] once wrote that the total world population during the year 8000 B.C. has been estimated at only five million people. It took almost 10,000 years from that date up to A.D. 1650 to increase the global population to 500 million. After 200 years, in 1850, the population doubled and became one billion people. And then the thing began to become brisk indeed. Now it took only 80 years by 1930, to double the world's population once again. In about 35 years from 1965, population will double again this time to four billion, according to population scientists, and every 35 years thereafter. In underdeveloped nations with big populations, the rate of doubling is further cut down to only 18 years! And it must be remembered that every additional human being added to the planetary load will demand his share of resources in order to survive.

Why is the staggering growth of population all over the world considered mankind's Achilles Heel? The simple answer is that our concept of a world with an unlimited space and resources is basically wrong. This is a limited earth with a limited amount of oxygen, water, trees, soil, minerals and marine resources. And to support the insatiable needs of a growing global population, we will have to press upon these limited resources until we will finally use up the last drop of fossil oil, the last grain of rice, the last morsel of meat, the last iota of everything in this plundered earth.

According to Nathaniel P. Reed again (Assistant Secretary of Interior for Fish, Wildlife and Parks, U.S.A.) in his thought-provoking article in the New York Times, "We are finally waking up to the awe-filled truth that as a people we have been living high-on-the-hog without regard to the long range consequences of achieving our short term goals. Each day now, we are assaulted by the spectacle of decaying cities,

[4] Reed, Nathaniel, P. *Spacecraft Earth Is Overloaded.* New York Times, August 6, 1974.

garbage-strewn countrysides, tasteless strip developments, filth-laden streams and lakes, irritating transportation snarls, chocking air, incessant noise and the all-too-frequent disregard for the other organisms that share our planet."

One of the more obvious results of over-population is starvation or famine. The supply of food can not cope up with the growing population. This has been dramatically underscored in the subcontinent of India where a crop failure brought about by sudden adverse climatic change or weather conditions can bring about the death for millions of people.[5] It has been estimated that the population of India is increasing at the rate of about 10 million people a year. In five years, therefore, more people will enter the Indian mainstream than there are people now living in the Philippines.

Another possible result of over-population is social ferment[6] that often breaks out in wars both civil and external or hostilities between and among nations. Marvin Harris who made an extensive survey of wars among primitive people has found out that wars are really rational. They are waged for practical considerations most often related to survival. He advanced the belief that if "wars are fought, as some believe, primarily because man is warlike, instinctively aggressive, an animal who kills for sport, for glory, for vengeance or for the sheer love of violent excitement," then the human rage is doomed because nothing can prevent those missiles from flying.

Harris believed that wars are the effect of a sense of danger among groups of people when their numbers are multiplying and the sources of food supplies are dwindling. In effect, it means that unconsciously, people are driven to wars in order to thin off growing populations, their own as well as their enemy's, in terms of the mortality among combattants and non-combattants, infanticide, the fall in birth rate brought about by the absence of the fighting men and the increased burden among the womenfolk to take over economic functions while their men are away fighting.

Every single child born in any country must partake of the scant and depleted artificial and natural resources of the country concerned. Computers have made it possible the computation of the cost of supporting a single human being on earth in terms of monetary value, ranging from less than $3000 in a lifetime for those born in the rural and impoverished areas of India, Pakistan and China, many African countries and some Latin-American countries, to more than $1 million for a person born in the highly urbanized and developed industrial societies.[7]

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[5] Vogt, William. *People*, p. 107.
[6] Harris, Marvin. *Cows, Pigs, Wars* and *Witches* (Primitive Wars), p. 48.
[7] Vogt, William. *People*, Bartholomew House, Inc., New York, 1961.

Every single person born in this world, whether in the jungles of Papua, New Guinea, or in the skyscrappered splendor of Manhattan in New York, will partake of the world's resources. A certain area of the arable land must, in a manner of speaking, be devoted to him. He will consume many thousand times his weight in meat and grains to be able to ingest the protein and carbohydrate needed for survival. He will use up energy all his life whether in the form of burning cow's dung in the hills of India, or the fossil fuels in the megalopolis of Tokyo. He will use up housing space, recreational space in the form of golf courses and park areas, hospital space, restaurant space, hotel space, cemetery space and thousand of other "spaces". He will consume cosmetics, clothes, medicine, electricity for his television and refrigerators, water, oxygen and perhaps one million and one other necessary items for comfortable living. He must be provided with transportation, a means of employment, schools, playgrounds, books, theater, household appliances, social welfare projects, churches, markets, roads, bridges, harbors, airports and so on. And depending upon his life-style, he will considerably add to the problem of environmental pollution.

Many people often ask questions which in the final analysis, are inane and stupid because the answers are too obvious. Why are the prices of basic commodities going up? Why is it hard to find an apartment for rent? Why are there electric brownouts? Why are there too few jobs for our vast turn-out of school graduates? Why are there mounting traffic problems? The answer is, of course, people. There are too many people in this world already.

Take for example a nasty and onerous problem that is plaguing the residents of every growing city the world over. This is the perennial traffic problems. Traffic does not get snarled for no reason at all. There must be a fundamental cause for this thorny urban headache. Traffic engineering, re-routing of vehicles, strict enforcement of traffic rules and regulations, no parking, the upgrading of drivers' skill, the education of pedestrians on the proper way to cross streets, etc., do not seem to dent the problem.

Is it not plain as daylight that the cause of traffic snarls and confusion is people? Many streets and avenues were designed and constructed decades ago to service a certain number of residents in an area. As the people increased in number of unchecked population growth and migration, as they doubled, trebled, quadrupled and so on, the streets were not widened accordingly. It is not to be expected that a two lane street good only for kalesas and an occasional vehicle many years ago could meet the traffic of a population which has since then vastly increased in number. How can the city's streets and avenues and highways meet the proliferating number of pedestrians and commuters, the

vastly increased number of vehicles? There are ten times more commuters and pedestrians today than twenty years ago, ten times more motor vehicles, ten times more sidewalk vendors, ten times more materials and human cargos disgorged by ships and aircrafts and so on. In other words, facilities should have kept up with the mushrooming growth in human numbers and that there should have more roads, highways, bridges, overpasses, underpasses, parking spaces and traffic facilities, ten more times in order to cope with the traffic problem. Since these vital facilities did not grow correspondingly, we have the traffic situation today in which commuters from a suburb going to a point in the metropolis may use up more time than a passenger of a jet aircraft going to another country in Southeast Asia.

And, finally, the proliferation of people which is increasing in a geometric progression, that is, virtually multiplying like the rabbits of Australia is the number one cause of environmental degradation. The entrails of the earth are virtually being disemboweled without regard for ecological and biotic injury to provide billions of people with the metals and minerals necessary for industry. In some parts of the world and particularly in underdeveloped areas overused lands are still being heavily grazed to support cattle and sheep population which are the mainstays of the nomadic and pastoral tribes, a practice which will enlarge what used to be arable lands that are now lost to the shifting sands of the desert.

Proliferating men also degrade the environment by their vast agricultural activities. No living person now can estimate the effect on climate and weather by the impounding of flowing rivers in massive dams. No one can estimate the injury caused by chemical fertilizers to raise agricultural productivity, the havoc caused by pesticides, fungicides and herbicides which while raising farm output also kill wildlife, and poison the soil, rivers, streams and oceans. Some edible fishes have been so infected with pesticides they are reported unsafe for human consumption.

Hand in hand with agriculture, industry also contributes to the poisoning of water, soil and air. Daily, the factories unload their gaseous wastes and particulates to the atmosphere. Motor vehicles, potential carriers of death with their carbon monoxide, monocarbons and other lethal emission are adding to the killer smogs hovering like the shadow of the Grim Reaper above the major cities of the world. And as the population of the world doubles every 35 years, the lethal load of poison now degrading the air, water and soil of the earth will continue to increase until in the not-so-distant future the planet which we call our home can not take it anymore. When the fragile ecosystem of the world is destroyed, we can begin to start counting the ticking of the ecological time bomb which can destroy us all.

The population of the world today stands at four billion souls. Few among us at present can conceptualize that staggering number of people. If you were at the very start of human civilization 10,000 years ago and started counting, it is assured that you are still counting today without reaching the four billion mark. According to biologists four billion people is already too many people living on this groaning planet: four billion eating, breathing, defecating, urinating, consuming, struggling, fornicating, multiplying mass of humanity. And that is only part of the picture. This mass of humanity is doubling every thirty-five years and not even the most effectively managed population control program can stop this proliferating humanity short of considering the act of producing a baby beyond the second child criminal!

The only way for civilization to get a breathing spell from the headlong rush to doom and perdition is to attain the so-called zero rate of population. It means that not another single human being must be added to the present population level of the world. It implies that every married couple on earth should not reproduce beyond two offsprings and that in over-populated countries like the Philippines (50,000,000 people by latest count), and India (600 million), and China (1 billion) every married couple should not produce more than one offspring, to give the population a chance of levelling off and decreasing.

It may come as a surprise to many but the only way to hold and reverse the injury to the environment brought about by man's economic activities is first to stop the galloping population of the world, and unless civilization can do this, the most far-reaching legislation both national and regional, as well as international, and the most effective population control program can not dent the growing problem of global environmental pollution.

A GEOGRAPHICAL APPRAISAL OF COBB-DOUGLAS PRODUCTION FUNCTION AS A MEASURE OF INDUSTRIAL EFFICIENCY

by

FRANKLIN E. KLU*

INTRODUCTION

The objective of this paper is to examine the Cobb-Douglas Production Function as a tool for estimating the efficiency of manufacturing concerns. The paper also seeks to question the basis of production functions as suitable tools for analyzing dynamic manufacturing systems, and proposes an alternative framework for such purposes.

The concept of efficiency has long intrigued economists and econometricians as evidenced by the periodic studies of the subject. Yet it is a concept which is not a monopoly of economists, even though empirical estimation of efficiency is most pervasive in economics.

The notion of efficiency is of fundamental importance in the economic-geographic analysis of industrial firms. The concept of efficiency is nebulous and has given rise to considerable debate as to how to evaluate the efficiency of industrial firms. Ideas of efficiency are so diverse that efficiency has been employed to refer to many different situations. Consequently numerous and diverse methods for measuring empirically the efficiency of the industrial firms have surfaced. One of such is the Cobb-Douglas Production Function. In order to avoid any ambiguous notion of efficiency, it is imperative to operationalize the concept as it is often employed in empirical studies.

The Concept of Industrial Efficiency

Though efficiency is a familiar concept, yet it is an elusive one. Suppose one wants to determine or evaluate the efficiency of two firms A and B, each with identical labour force, producing the same products or services with the same type and quantities of equipment and machinery. At this simplest level of efficiency analysis, the firm producing the greater output, other things being equal, is more efficient. Such a definition is, however, too imprecise to provide a satisfactory picture of efficiency in operation, for in such a straightforward decision no allowance is made for the different difficulties with which the two hypothetical firms have to cope.[1]

* Dr. Franklin E. Klu is with the Department of Geography, University of Ghana, Legon, Accra, Ghana.

1. Hunt, H.G. (1965), *Industrial Economics* (Pergamon Press Ltd., Oxford, pp. 55-69.

If, on the other hand, one attempts to determine the more efficient firm, not by its output alone but how well its management was doing its job, one might use very different criteria and the result of the comparison might be different more particularly if the firms cope with different problems. Thus, there are two different questions of efficiency, which though close and both partly decided on the basis of the output of the firms in question, may have different results with different practical implications.

The first type of problem is related to the determination of what is sometimes termed "social efficiency", while performance based on very different criteria appropriate to judging management performance is termed "management efficiency".[2] The rationale underlying social efficiency is that the resources of a nation be allocated rationally so as to produce maximum output to satisfy societal needs. In case of the two hypothetical firms, the same products or services from either of the firms would satisfy societal demand, but if there were a decision to be made as to which firm made better use of the nation's resources, **ceteris paribus**, the firm with higher output would be chosen.

These two concepts of efficiency already illustrate some important characteristics of the notion of efficiency. First, they are both concerned implicitly with decisions or rather with providing material to assist in decisions. Secondly, just because they are concerned with decisions they are concerned with ranking the alternatives or putting them on a scale. The ranking achieved may be different for either of the two hypothetical firms in question. For each firm to decide the difficulty of its task, it is necessary to specify the range of opportunities open to the management. These ranges may vary from one firm to another and thus make a considerable difference to the situation with which they have to cope.

Yet another concept of efficiency is the one termed target or technical efficiency,[3] in some respects an intermediate notion between the two concepts of efficiency just mentioned and in fact overlapping them. A target or technical efficiency is concerned with a situation where a number of different firms operate in a number of different environments. Target efficiency answers type of question: if only we could change the management of this firm for the best of its kind, how much output could we obtain? Technical efficiency, on the other hand, answers such questions as: if only we replaced this technique by the one producing most in its particular environment, how much more could we obtain? Again the question of how difficult such a task is to be achieved is not raised.

Targets are varied according to changing business environments. The failure of any firm to approach its target level can be taken as

2. Hall, M. and Winsten, C. (1959), "The Ambiguous Notion of Efficiency", *Economic Journal* Vol. 69, pp. 71-86.
3. Hall, M. and Winsten, Co., *ibid.*, pp. 71-86.

prima facie evidence of inefficiency. It may be discovered at a later time that the original targets set were unreasonable or that special factors had arisen which had been unforeseen when the original targets were set. The use of targets as a measure of efficiency is undoubtedly of great practical value in providing a quick assessment of efficient operations in the short-run. Their use as a means of comparing efficiency between various firms or for one firm over a number of years is more limited. Comparative efficiency can be expressed only in ordinal terms by this method, since differences in targets can never fully account for the various circumstances in which firms operate.

Yet a further concept of efficiency is that held by equity shareholders of firms in relation to return on equity capital termed "capital or investment efficiency."[4] This concept of efficiency has gained a wider currency than is really justified. This efficiency is normally measured in monetary terms and it has been widely held that the most efficient use of resources is the most profitable, that is, that which yields the largest output (sales-return) over input cost. In other words, the profit margin of a firm is a measure of its efficiency. Such a measure, however, is inherently an arbitrary one until a valuation is put upon the geographical distribution of income which affects sales-return and on the current factor prices.[5] Given that, it would follow that differences in efficiency in this sense, that is, the rate of profit on equity capital, at any one time, are the cumulative results of either disequilibrium positions which will be removed by competitive forces or gains arising from some specialized resource techniques or environmental characteristics, or are attributable to the special qualities of the particular entrepreneur and management.

It is rather arbitrary to regard the size of the profit as a measure of efficiency. In the first place, the size of the profit has to be considered in relation to the size of the firm. One would normally expect large firms to have larger profits than small firms, but this does not mean that large firms are necessarily more efficient than small firms. Moreover, the cost of inputs will depend on factor prices, for example, material prices, wage and salary levels in different firms and the value of output will depend upon the price of the products or services produced and the volume of sales. While it is true that a firm can play a part in determining its selling and buying prices, the latter are also subject to influences that have nothing to do with the efficient operation of any particular firm.[6] A firm may, therefore, be able to increase its selling prices without losing sales when the demand for its products

4. Scott, J.A., *op. cit.*, pp. 1-155.
5. Scott, J.A., *idem., pp. 1-155.* See also Speight, H. (1969), ***Economics and Industrial Efficiency: Introduction in Managerial Economics*** (Macmillan, London), pp. 1-10.
6. Hunt, H.G., *op. cit.*, pp. 59-69.

or services rises as a result of an increase or upsurge of the national income, or income per capita; capital costs may fall due to a change in the monetary policy of the government; labour costs in a particular industry may rise less swiftly than selling prices during a period of inflation. When a firm shows an increased profit margin over a number of years, it does not necessarily mean that it has been increasing its efficiency. Moreover, it is not possible to gauge the relative efficiency of two firms of the same size in different or the same industries by comparing the profitability of each firm. Differences in the profits between firms in different or the same industries might well be accounted for by differences in purchasing conditions in the factor market, or differences in selling conditions in the product or service market, or differences in managerial capacities for bargaining.[7]

In short, since efficiency can be utilized within different contexts by different scholars, the operationalization of the concept of efficiency may be meaningful only with reference to the purpose, goal and objective for which a measurement of efficiency is made. Similarly, the purpose for which a measurement of efficiency is made will largely determine the method employed.

Many models and analytical techniques have been employed in empirical studies to estimate or evaluate industrial efficiency. These techniques include, among others, labour-output ratio, capital-labour ratio, capital-output ratio, management ratio analysis, allocative efficiency approach, technical efficiency approach, Farrell's approach to the measurement of production efficiency, etc. The inadequacies of these analytical models have been reviewed and commented upon elsewhere.[8]

The deficiencies of the existing approaches to measuring efficiency should dictate the minimum requirements that a new concept of relative economic efficiency should meet if it is to be at all useful. It should account for firms that produce different quantities of output from a given set of measured inputs of production. This is the component of differences in technical efficiency. It should also take into account that different firms succeed to varying degrees in maximizing profits, that is, in equating the value of the marginal product of each variable factor of production to its price. This is the component of price efficiency. Thirdly, the test should take into account that firms operate at different sets of market prices. The decision rule on profit maximization yields actual profits, as well as quantity of output supplied and quantities of variable inputs demanded, as a function, **inter alia**, of input prices. It is clear that two firms of equal technical efficiency which have successfully maximized profits would still have different value of profits as long as they face different prices. Relative economic efficiency thus

7. Hunt, H.G., *ibid.*, pp. 55-69.
8. See for example, Klu, F.E. (1979), *Efficiency of Small-scale Auto Repair Workshops in Accra.* (Ph.D. Thesis submitted to the Department of Geography, University of Ghana), Chapter 4.

combines both technical and allocative efficiency. Attempts to empirically test the relative economic efficiency of industrial firms have resulted in the use of numerous production functions or what McFadden termed profit functions.[9]

The traditional concept of production function centered on industry's aggregate production function, which merely expressed the relationship between aggregate output and the aggregate inputs of that particular industry. There are both conceptual and empirical objections to such aggregate analyses. Conceptually, there is little basis for assuming a simple and stable relationship between inputs and outputs either at the sectoral or even at the industry level. Empirically, since a production function may evolve from extra-economic considerations, the assumption of the existence of an aggregate production function, implying an economic law of production will have dubious validity.

Part of the sceptism about aggregate functions stems from the fact that even in recent years, it has not been possible to obtain acceptable estimates of structural parameters even from engineering data.[10] Also, in many empirical studies, as Nerlove observed, there have been wise and irreconciliable differences between the estimates of elasticity of substitution, for example, even with small differences in time period and concepts.[11] Both Nadiri[12] and Walters[13] have given a few other minor shortcomings in the use of production functions in empirical studies.

In spite of these shortcomings, production functions have been extensively employed by econometricians. If nothing at all, the production functions sometimes have the desirable neo-classical properties in the sense of being continuous and possessing positive marginal products and being subject to diminishing returns. Moreover, the production functions provide a seemingly convenient framework for investigating the structure of both atomistic units such as the firm and aggregate economic units such as whole sectors or economies. In the assessment of the growth prospects of an economy or parts of it and the identification of the components of growth and malleable policy variables, economists almost have invariably fallen, whether explicitly or implicitly on some

9. McFadden, D.L., "Cost, Revenue and Profit Function" in McFadden D.L. (1971) (ed.). *The Econometric Approach to Production Theory* (Amsterdam).
10. Kurz, M. and Manne, A.S. (1963), "Engineering Estimates of Capital-Labour Substitution in Metal Machinery", *American Economic Review*, Vol. 53, No. 4, pp. 662-679.
11. Nerlove, M.L., "Recent Empirical Studies of the CES and Related Production Functions" in Brown, M. (ed.) (1967). *The Theory and Empirical Analysis of Production* (National Bureau of Economic Research Studies in Income and Wealth, Vol. 3, Columbia University Press).
12. Nadiri, I. (1970), "Some Approaches to the Theory and Measurement of Total Factors Productivity" *Journal of Economic Literature*, Nos. 8-4, pp. 1157-1177.
13. Walters, A.A. (1963), "Production and Cost Functions — An Economic Survey", *Econometrica*, Vol. 31, Nos. 1-2, pp. 1-66.

production function.[14] Thus production functions have been essential tools for econometricians for the empirical analysis of industrial efficiency and performance. No attempt will be made here, however, to present a complete survey of the sub-literature on production functions as more comprehensive surveys have been undertaken by Walters[15] and Narlove.[16] In this section, only the commonest production function will be reviewed: the Cobb-Douglas production function.

COBB-DOUGLAS PRODUCTION FUNCTION

Historically, perhaps the most important of the neo-classical production functions has been the Cobb-Douglas. For nearly four decades it reigned as the springboard from which econometricians dived into the depths of theoretical and empirical investigations of productions at both the macro and micro-economic levels. The long reign of the Cobb-Douglas production function could be attributed to its simplicity apart from its obvious neo-classical properties. Specifically, empirical estimates of this neo-classical formulation, the Cobb-Douglas production function, can provide indications of the returns to scale, the marginal productivities and efficiency of the production inputs and the elasticity of input substitutions.[17] Mathematically, the Cobb-Douglas production function has the simple form:

$$Y = AK^{a1} \quad L^{a2}$$

where

Y = Output
K = Capital Input
L = Labour Input
A = Multiplicative constant, an efficiency parameter
^{a1} = elasticity of output with respect to capital
^{a2} = elasticity of output with respect to labour

The Cobb-Douglas production function is amenable to the methods of linear statistical estimation and for this reason it has featured prominently in applied econometric analyses. The function can be linearized into the form:

$$\text{Log } Y = \log A + \propto \log K + \beta \text{ Log } \quad L$$

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14. See, for example, Ferguson, C.E. (April 1965), Time Series Production Function and Technological Progress in American Manufacturing", *Journal of Political Economy*, Vol. 73, No. 2, pp. 135-147; Brown, M. and De Cani, J.S. (1963), "Technological Change and the Distribution of Income", *International Economic Review*, Vol. 4, No. 3, pp. 289-309, Nelson, R.R. (Aug. 1965), "The CES Production and Economic Growth Projection", *Review of Economics and Statistics*, Vol. 47, No. 3; pp. 320-328.
15. Walters, A.A., *op. cit.*, pp. 1-66.
16. Nerlove, M.L., vide, *op. cit.*, 44.
17. Liedholm, C. and Chuta, E. (1976), *The Economics of Rural and Urban Small-Scale Industries in Sierra Leone.* African Rural Economy Paper, No. 14, 1976, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, U.S.A.

The above mathematical notation means that when particular values are assigned to labour and capital, the product is not uniquely determined but rather there is a set of values for the product or its logarithm Y, each having attached to it a probability. In other words, the mathematical expectation of Y is expressed as a function of capital and labour inputs. Zellner, Kmenta and Dreze have argued that the problem of specifying and estimating a model of the profit-maximizing firm with a Cobb-Douglas production is not insurmountable for it is found that the classical least square regression provides consistent estimators of the parameters of the Cobb-Douglas function.[18] Thus, ordinary least square regression can be employed to estimate its efficiency parameters.

Many of the econometric studies dealing with relative economic efficiency and factor substitution have employed the neo-classical formulation of Cobb-Douglas.[19] This neo-classical model has not only provided a powerful tool for econometric analysis but it has guided economic theorists to empirically investigate the relative economic efficiency of business enterprises; among other things.

The employment of Cobb-Douglas production function model is, however, subject to major conceptual and technical ambiguities and problems that need serious attention. The neo-classical model assumes that the inputs for the production systems of the firms in an industry are homogeneous and the same. In essence, all firms in the same industry employ the same quantity and quality of factors of production as inputs for their production processes. Similarly, the Cobb-Douglas production function assumes constant managerial capabilities for all firms in question. Thirdly, the model assumes that the economic environment in which the firms operate has the same magnitude of influence on all firms or it is static. Furthermore, the model assumes that the tastes, incomes and demand are constant so that the output of the firms will be measured in relation to the input factors save others. These assumptions are rather rigidly restrictive and untenable for the production process is not only a function of the inputs but also other influences such as the nature of the demand, the distribution of income, the propensity to require goods and services, the nature of government policy towards manufacturing industry, etc.

Apart from these questionable assumptions, the Cobb-Douglas production function has some properties that may not accurately depict

18. Zellner, A., et al. (Oct. 1966), "Specification and Estimation of Cobb-Douglas Production Function Models", *Econometrica*, Vol. 34, No. 4, pp. 784-795.

19. See, for example, Lau, L.J. and Yotopoules, P.A., *op. cit.*, pp. 94-109; Aigner, D.J. and Chu, S.F., *op. cit.*, pp. 26-839; Hoch, I., *op. cit.*, pp. 325-326; Seita, W.D., *op. cit.*, pp. 505-511; Zellner, A., et al., pp. 784-795; Gun, G.T. and Douglas, P.H. (1941), "The Production Function for American Manufacturing in 1919", *The American Economic Review*, Vol. , pp. 67-80; Bronfenbrenner, M. (1944), Production Function; Cobb-Douglas Inter Firm, Intrafirm", Econometrica, pp. 35-44; Gun, C.T. and Douglas, P.H. (1941), "The Production Function for Australian Manufacturing", *Quarterly Journal of Economics*, Vol. 56, pp. 108-129.

the production relationships of small-scale industry. Specifically, the assumption of the Cobb-Douglas production function that the underlying production isoquants are smooth and continuous may strain credulity, particularly if one believes that there are few, if any, production choices available to small-scale industry.[20]

Furthermore, the claim that the Cobb-Douglas production function purports to measure factor substitution because of differences in the relative efficiency of the factors, can even be doubted. The Cobb-Douglas production function does not shed much light on the factor substitution issue because one of its properties is that the elasticity of substitution is always equal to unity. This is a rigid assumption which cannot be necessarily valid. A key property of any dynamic functional form of the production function should be that the elasticity of substitution parameter could range from zero to infinity so that it can reflect the potential differing extent to which factor inputs, for example, capital and labour can be substituted for one another in production. In essence, a shortcoming of the Cobb-Douglas production function is the pre-specification of the elasticity of substitution parameter.

Some analysts have questioned the inputs for the Cobb-Douglas production function. Redder, for example, argues that in economic theory a production function gives the relationship between the physical quantities of the factors that a given firm employs and the quantity of that firm's output. He stated, **inter alia**:

> "The Cobb-Douglas function must give us the relationship between the output of any firm and the quantities of the factors that it actually uses. Each point on the Cobb-Douglas function refers to the actual output of some firm corresponding to the actual quantities of the factors that it uses. The Cobb-Douglas function is thus the locus of the output and factor quantities of all the firms included in the study...[21]

Redder, however, argues that the inputs employed by many analysts including Douglas were not physical quantities but rather derived input quantities which do not correspond to economic theory of production function. Douglas employed value added in manufacturing as a surrogate of output and physical input of labour services as well as the value of plant and equipment owned to represent capital. Because of the differences in the nature of the inputs for the model, Redder contends that the empirical results of many Cobb-Douglas function analyses are not production function analyses in the usual theoretical sense and that their divergence renders them relatively useless for the inductive verification of production and distribution theory.[22] Labour input also raises

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20. Liedholm, C. and Chuta, E., *op. cit.*, p. 77.
21. Redder, M.W. (1943), "An Alternative Interpretation of the Cobb-Douglas Function" Econometrica, Vol. II, pp. 259-264.

some measurement problems conceptually. Labour should be measured in terms of a standardized unit; and so there is the problem of adding together labour units of different quality. Obviously the best indicator of labour's quality is its marginal product which will be measured by the wage rates earned in some reference or base year. This suggests that labour should be weighted according to its remuneration in the base year and then aggregated to find the quantity of labour measured in standard units. In practice, it is necessary to classify labour into broad groups according to age, sex and perhaps education or skill. The weighting system can be adopted with these broad groups. However, the question arises as to which sort of average should be used? The theory of aggregation suggests that a geometric average would be the best approach. But unfortunately the vast majority of statistics are published as arithmetic averages or totals, so the use of geometric average is not a practical proposition. For practical analysis, many analysts have often used some simple unweighted concept, that is, the number of persons employed or man-hours. Since skill and the composition of the labour force change over time, it is clear that biases are introduced into time series studies of production function.

The main problems occur in the measurement of capital. In production functions the concept of capital input required should correspond to the capital service which is performed during the period for which we calculate output and labour input. The problem, therefore, is the old distinction between a stock and a flow. Consider, for example, two machines which produce identical services each year; but suppose that one will last 40 years and the other 20 years. The machine with the longer life will command a higher price on the market than the machine with the short life. But the rent paid for one year's service from these two machines should be the same. And although one machine is more valuable than the other, the two machines have exactly the same effect on current production when they are combined with the same amounts of labour.

In addition to all the usual index number difficulties in combining heterogeneous goods into one measure, particular problems occur with capital because of the process of technical change and innovation. The inventory of capital goods includes different kinds of machines, buildings and inventories at different stages of their cycle, and of the process of technological change. To combine them into a single measure will necessitate their reduction to money values. But the value of a piece of existing capital equipment is determined by its expected rate of profit, and of course the existing rate of profit. Thus we cannot use capital (K) and the expected rate of return (R) on capital as though they were independent measures; the value of R enters into the computation of K.

22. Redder, M.W., *ibid.*, pp. 259-264.

Many other problems that enter into the measurement of capital can often be dealth with by using **ad hoc** methods. For example, the capital measures available in practice usually do not allow for the fact that certain machines are unemployed or under-employed. Since the labour inputs, especially if man-hours is used, do allow for the extent of unemployment in labour, it seems that some allowance should be made for the unemployment of capital also.

In practical application, most investigators have used a concept of net capital rather than the gross capital. This involves the depreciation of capital inputs employing either the straight-line depreciation, accelerated depreciation method, present value method or the Giffen method of capitalizing the income from capital by using a year's purchase measure, all of which have their theoretical shortcomings of capital measures and the empirical crudities.[23]

The measurement of inputs for the model makes one sceptical and if not cynical about the estimates of production functions that are based on such unsatisfactory measures of capital stock. But such reflections, though relevant, are not critical for judging the production function approach. The true issue is whether one can explain more and predict better with, rather than without, capital stock series.

Walters, for example, has cogently argued that the Cobb-Douglas model of production, although internally consistent and useful for many analytical and empirical purposes, is of very limited use for analyzing the production functions of firms. This is because one of the most important aspects of the firm, its size, is indeterminate.[24] Clearly, a satisfactory theory could predict the size of firms from observable variables and one should be then able to test the theory in this respect. The question as Walters posed, therefore, is can one adapt the theory so that the size of firm is determinate?

Walters provides two alternative answers which negate the utility of the production function. The first is to drop the assumption of perfect competition which automatically weakens one of the premises on which the Cobb-Douglas model was structured. Suppose instead that there are conditions of imperfection in some or all of the markets in which the enterpreneurs participate. Formally this is easy to incorporate in the analysis by specifying the elasticities of demand for output, of labour supply and of the supply of capital input. But such a development does throw the baby out with the bath water.

The second approach is to suppose that there is another type of input which is distinguished from labour and capital because it cannot be purchased on the market. This input is entrepreneurship. It is this

23. Sneight, H., *op. cit.*, pp. 182-195.
24. Walters, A.A. (1970), ***An Introduction to Econometrics*** **(Mcmillan & Co., Ltd., London), pp. 269-339.**

limitation of entrepreneurial capacity that determines the size of a firm.[25] But because one cannot purchase entrepreneurship on the market, one can only employ one's own capacity. Thus, the distribution of firms is explained by the distribution of entrepreneurial capacity in the population. However, entrepreneurial ability cannot be measured independently of the output of the firm. The limited supply of entrepreneurship to a particular firm means that there may be increasing returns to the variable inputs up to the point where the entrepreneurial capacity is fully employed, then decreasing returns to the variable inputs will appear.

In addition to the difficulties already discussed in relation to the production function, it will be observed that essentially the Cobb-Douglas production function is structured on logarithmic regression analysis which takes the form:

$$\text{Log } X = \log A + \alpha \log K + \beta \log L$$

The above logarithmic formulation suggests that the simplest method of estimation is to carry out a least-square regression of log X on log K and log L. Indeed least-squares estimates have been the most popular approach in practical application. Whether it is the best form of estimation depends very much on the purposes for which the statistics are required. If one is concerned merely with making the best prediction of the value of output (X) for given capital (K) and labour (L) the least squares approach is appropriate.

In many instances, however, one is not primarily concerned with forecasting the levels of output; the prime purpose may be to check the hypothesis that α is equal to the labour's share, or that the sum of the Cobb-Douglas coefficients $\alpha + \beta$ is unity. In such a situation, one needs to estimate the structural coefficient α and β of the model.

The least-squares estimates of α and β will be the best estimates provided that the independent variables labour (L) and capital (K) may be taken as given constants, that there is no feedback effect from output (X) on to labour and capital, and that the disturbance term is distributed independently of the values taken by labour and capital.[26] However, such conditions as required for least-squares estimation are not usually met.

The interpretation of the least-squares estimated parameters also raises some pertinent questions. The employment of regression analysis in the Cobb-Douglas production function model implies that the formation basically establishes production relationships between the dependent variable, output, and the independent variables, capital and labour inputs.

25. Walters, A.A., *ibid.*, p. 281.

* This must be interpreted as conditional, however, since it hinges on the fact that the true relationship between the variables is in fact linear in the logarithms. If it is not linear in the logarithms, if, for example, it has a quadratic form, then a linear prediction will involve errors of specification.

26. Walters, A.A., *idem.*, p. 319.

From such production relationships the labour and capital coefficients are estimated which indicate the relative efficiency of the factor inputs. Assume that two hypothetical firms A and B in the same repair and maintenance industry have labour coefficients of 0.900 and 0.100 respectively in relation to output and 0.475 and 0.505 respectively as the capital coefficients in relation to output. In other words, firm A has a returns to scale coefficient of 1.000 while firm B's coefficient of returns to scale 1.000. Invariably, results of Cobb-Douglas function for the two hypothetical firms may be interpreted that firm A is more efficient than firm B in terms of labour while firm B is more efficient than firm A in terms of capital. Is there any statistical justification of this claim, when differences in the initial factor inputs are disregarded? The basic assumption underlying such an interpretation of efficiency is that the two firms utilize the same amount and quality of inputs. But this assumption may not be necessarily true. Granting that the two hypothetical firms employ the same quality and quantity of factor inputs, a minimum level of efficiency has to be defined below or above which a firm can be termed inefficient or efficient as the case may be. In effect, the interpretation and inferences of relative economic efficiency from regression coefficients derived from the production relationships are tainted with personal biases, speculation and arbitrariness.

Above all, this model for estimating the efficiency of the firms is spatial. It neglects the influence of spatial location on the performance of the firms.

A Systems Framework for the Analysis of Industrial Efficiency

The behaviour or performance of any manufacturing production system is complex. Industrial firms are complex operating systems and their production behaviour is determined by numerous and complex elements or variables. In essence, it is being argued that if industrial behaviour, performance or efficiency is to be estimated, an analysis which involves many elements of the manufacturing system, then the most appropriate analytical conceptual scheme within which the efficiency of industrial establishments can be evaluated is the General Systems Theory.[27]

27. Von Bertalanffy, L. (1950), "The Theory of Open Systems in Physics and Biology". *Science*, Vol. III, pp. 23-29; see also, von Bertalanffy, L. (1950), "An Outline of General System Theory". *British Journal of Philosophy of Science*, pp. 134-165; Boulding, K.E. (1958), "General System Theory — The Skeleton of Science" in *Management* Science, Vol. II, pp. 197-208, reprinted in Buckley, W. (1968) (ed.), *Modern System Research for the Behavioural Scientist: A Source-Book* (Aldine Publishing Co., Chicago, Illinois, pp. 8-10; von Bertalanffy, L. (1968), *General System Theory*, Foundations Development *Applications* (Penguin Books); Cortes, F., Przeworski, A. and Sprague, J. (1974), *Systems Analysis for Social Scientists* (John Witey and Sons, New York); Emery, F.E. (1969) (ed.), *Systems Thinking* (Penguin Education).

A system may be defined as a complex of interacting elements.[28] The elements are the basic units of the system. These elements are closely interrelated so that a change in one element causes a change in all the other elements in the total system. The system therefore functions are a whole or operates on holistic basis with respect to all the elements within the system's boundary.

A system can be represented in a number of ways, for example, by diagram and models, showing subsystems or components, especially flow diagrams; by graphs, showing the trajectory of the system as whole from one state to another over a period of time; by matrices to show transitions of relationships, etc. The essence here is not to discuss the basic tenets of general systems theory but rather a suggestion of the use of the systems idea.

Within the broad framework of general systems theory, the efficiency or behaviour of industrial firms indicates that the location decision system, production-distribution system, and a system of public policies are the main elemental components which interact functionally and contribute to the working of the total system, that is, the overall performance of the firms. Figure 1 indicates the basic elements within the operating system of the industrial firms in their environment.[29]

The first major element that may account for the efficient operation of industrial firms is their location. Friedmann has argued that the decision as to "where" to locate a project or an enterprise is as important as the decision to invest in it, and the relative locational decisions that give birth to the establishment of industrial firms are important in influencing the efficiency at which they perform.[30] For example, the location decisions that give birth to the localization of the firms in any space economy could be a source of agglomeration economies which are crucial to the effective functioning of the industrial system. A direct consequence of such an interaction process and a functioning system is a spatial pattern of interrelationships and linkages that could be established among the firms.[31]

The second major element is the production-distribution process. As Forrester has also argued, the production-distribution system which forms

28. Hall, D.D. and Fagen, R.E. (1956), "Definition of Systems" *in General System Year*, Book I, pp. 18-28.

29. It is worth noting that for a given system, the environment is the set of all objects a change in whose attributes affect the system and also those objects whose attributes are changed by the behaviour of the system. Figure 1 therefore allows for energy or information from the firms' environment to influence the functioning of the firms while the output from the firms will also affect the environment in a feedback relationship.

30. Friedmann, J.R.P. (1966), "Locational Aspects of Economic Development" Land Economics, Vol. XXXII, pp. 213-227; see also, Friedmann, J.R.P. and Alonso, W. (1964) (eds.), *Regional Development and Planning. A Reader* (M.I.T. Press Cambridge, Mass.), pp. 1-13.

31. Forrester, J.W. (1966), *op. cit.*, pp. 213-227.

the core of any typical industrial enterprise,[32] entails the production processes on the one hand and the disposal of its goods and services to the customers on the other.

A crucial element of the production-distribution system is the management. Location decisions of the industrial firms may be made by the management or the entrepreneur. Decisions about the scale of operation are made by the management. Such decisions may concern the sources of material, capital and labour inputs for the effective functioning of the firms. In essence, management or entrepreneurial decisions are information flows or energy through the system which interconnect the location, the production-distribution and management systems intricately.

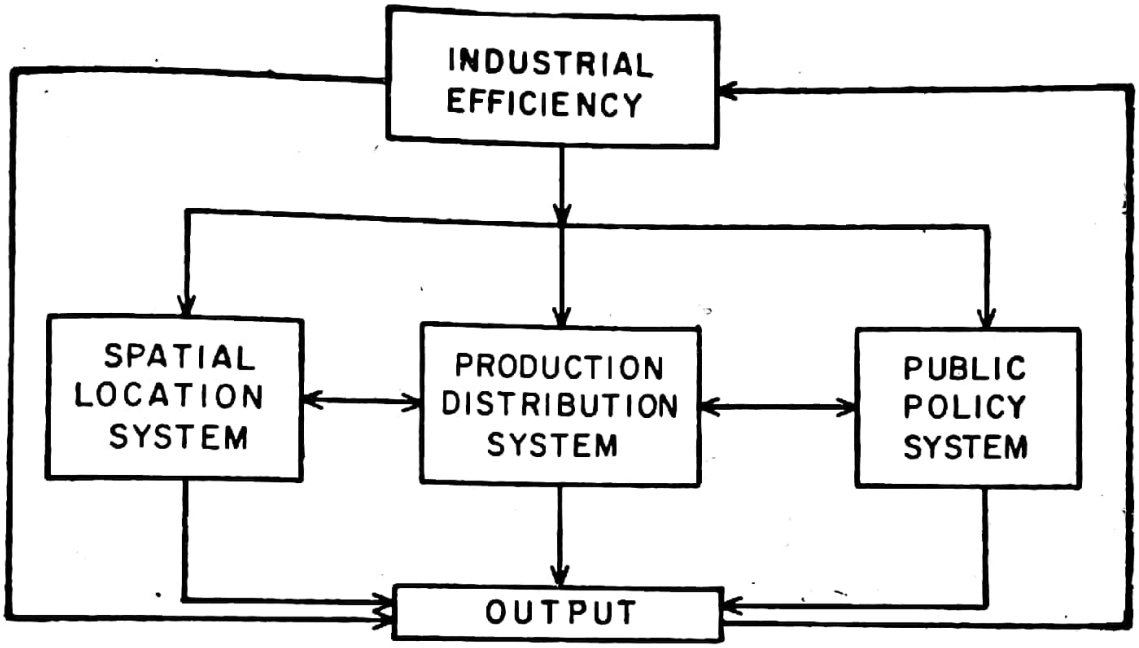

FIGURE 1. ELEMENTS OF AN INDUSTRIAL SYSTEM

Forrester epitomized these complex combinations as follows:

> "...efficient operation of an industrial firm involves management that mobilizes men, materials, money and methods to produce goods or services..."[33]

In essence, analysis of industrial efficiency involves the assessment of functions ranging from the designing of methods to procure or acquire materials, the conversion or manufacturing, selling and distribution of the goods and services, financing the procurement of the materials and accessories and general management of the firm.

32. Forrester, J.W. (1961), Industrial Dynamics (M.I.T. Press, Cambridge, Mass.), p. 21.
33. Forrester, J.W., *ibid.*

The third major component of the system that affects the efficiency of industrial firms is public policy. As economic activities, industrial firms operate within a particular socio-economic and political milieu with its legal, fiscal and institutional policies. In a mixed economy like that of Ghana, the individual firm is unable to operate successfully or optimally without the co-operation of the public authorities. The government may exercise its influence on the availability and allocation of material inputs through import licensing, foreign exchange controls, multiple exchange rates, etc.[34] Public policy is, therefore, an important element that may influence the efficiency at which industrial firms perform.

The systems' framework outlined, has shown that the elements of the manufacturing system interact functionally in a complex manner. Static models, such as Cobb-Douglas Production Function, are ill-equipped to capture or analyze the complex behaviour of dynamic manufacturing systems. What is needed, therefore, is a dynamic model which can adequately explore the inherent behaviour of the elements of the manufacturing system and changes that occur within the manufacturing system as a result of change or shifts in relevant attributes of the environment. In this regard, system dynamics offers a very promising challenge to all students of social sciences and planning as well as business management.

Industrial System Dynamics

Of the many branches of systems research, system dynamics is the most relevant for the analysis of industrial behaviour. Industrial dynamics is the study of the information — feedback characteristics of industrial activity to show how organizational structure, amplification (in policies), and time delays (in decisions and actions) interact to influence the success of the enterprise.[35] The methodology of industrial dynamics treats the interaction between the flows of information, money, orders, materials personnel, and capital equipment in an industry. Industrial dynamics thus provides a single framework for integrating the functional areas of industrial management — marketing, production, accounting, research and development, and capital investment.[36] Basically, system dynamics is an application of the principles of cybernetics to social science research problems, and provides both a quantitative and experimental approach for relating organizational structure and corporate policy to industrial behaviour.[37] In addition, industrial system dynamics analysis attempts to find the pressure points in the manufacturing system that can act as leverages to influence the behaviour of the industrial system as a whole.

34. Scott, J.A. (1950), The Management of Industrial Efficiency (Pitman & Sons Ltd., London), p. 19.
35. Molsberger, J. (1970), "The Role of Maintenance and Repair in the Development of Manufacturing Industries", *Industrialization and Productivity*, UNIDO Bulletin No. 17, pp. 58-88.
36. Forrester, J.W., *op. cit.*, p. 13.
37. Forrester, J.W., *ibid.*, p. 13.

Feedback — Loop Structure in A Manufacturing System

All changes in the system arise out of feedback structure. The feedback structure characterises causal interrelationships between elements of a manufacturing system. If changing one element causes change in another and that change in turn causes variation in the first, then the two elements are linked in a feedback loop.[38] For example, literacy rate (education) and productivity in an industrial establishment may be linked by feedback loop where productivity changes the levels of literacy which can feedback on productivity.

The dynamic behaviour of the manufacturing system is generated within the feedback loops. A feedback loop comprises two kinds of variables called LEVEL and RATE variables.

Level Variables: In a feedback loop, the level variables are accumulations within the system. Accumulation is a process that involves the passage of time, but at any point in time one can observe the quantity in the level. Thus each level variable results from accumulation or the inflows and outflows through time. In the manufacturing systems, for example, levels exists in information available to the firms, material inputs, orders, money, personnel, and capital equipment. In mathematical terms, levels are the time integrals of the net flow rates.[39]

Rate Variables: The rate variables show the change in level variable between two time intervals. The levels provide information inputs to the rate variables which control the flows. Rate variables depend only on information about levels. No rate can directly affect any other rate and no level can affect any other level directly. One level can affect another only through an intervening rate. Rates thus define the present, instantaneous flows between the levels in the system, and the rates correspond to activity, while the levels measure the resulting state to which the system has been brought by the activity.[40] Rate variables, in other words, determine how the available information is converted to an action stream.[41]

Figure 2 shows, according to the principles of system dynamics, the symbolic expression of a simple feedback loop structure linking level (condition) and rate (action variables).

Characteristics of Feedback Loop Structure

There are two basic characteristics of feedback loop structure. They are negative (goal-seeking) and positive (self-reinforcing) feedback loops. Negative feedback loops are goal-seeking or self-regulating and prevent

38. Forrester, J.W., *ibid., p. 13.*
39. Low, G.W., "Using System, Dynamics to Simulate the Past" in (ed.), Jeremy A. Cabloff, *Simulating the Past* (Albuquerque, University of New Mexico Press.
40. Forrester, J.W., *ibid.*, p. 68.
41. Forrester, J.W., *ibid.*, p. 68.

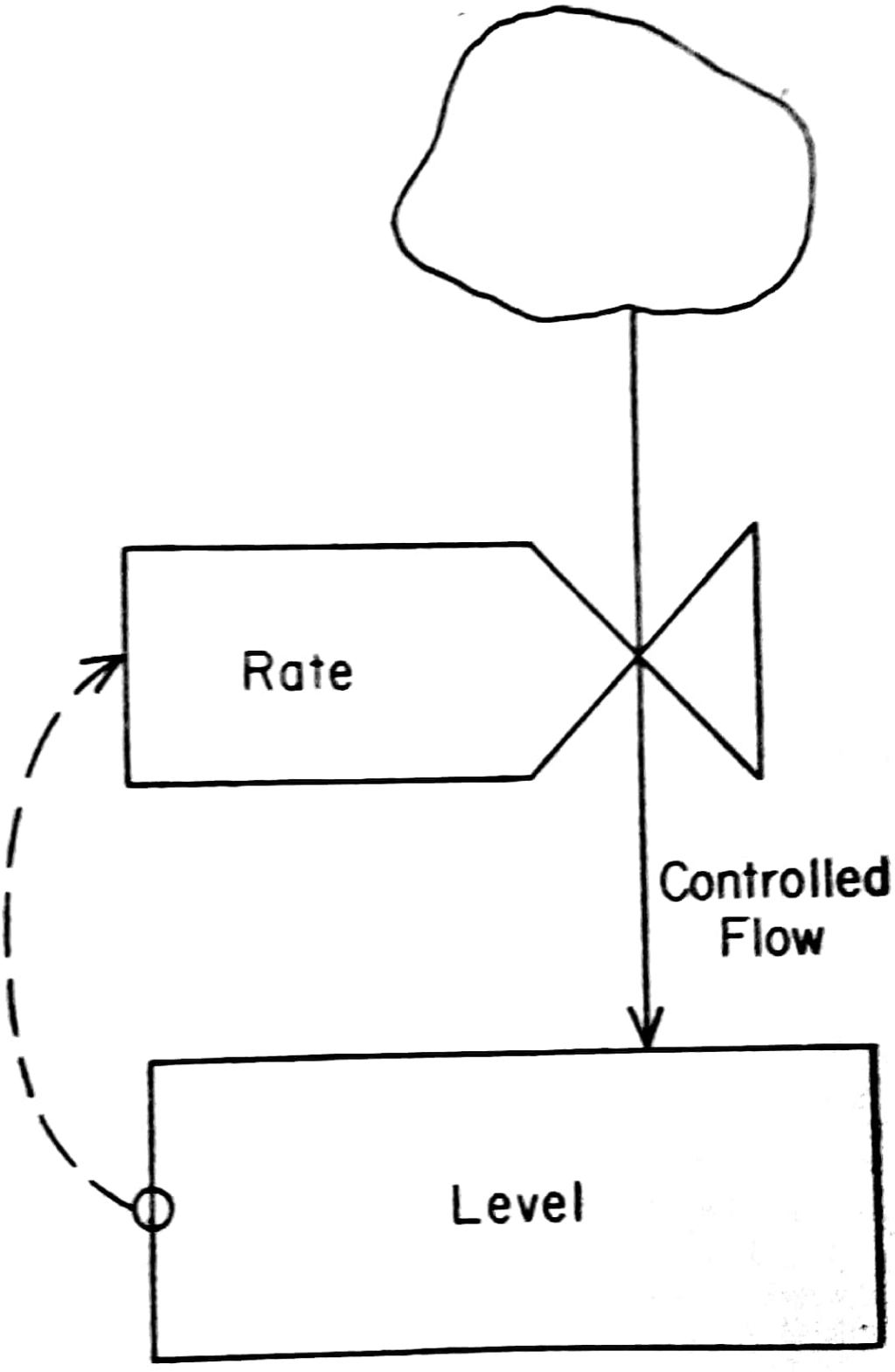

FIGURE 2. SIMPLE FEEDBACK LOOP HAVING ONE LEVEL AND ONE RATE

a system from loosing control. They respond to the discrepancy between the desired condition and the current or actual condition. The greater the discrepancy, the larger or faster will be the rate of changes. Positive feedback loops are shown exponentially in the system.[42]

Positive and negative feedback are important differentiations in system dynamics. According to system theory, a critical characteristic of dynamic systems is self-regulation or homeostatis. Self-regulation occurs within negative feedback loops. Thus, the survival of the manufacturing system, for example, implies feedback.

The creation of two or more feedback loops of different types permits a check to be placed on opposing forces. Multiple level variables with many feedback loops exhibit complex behaviour which the system dynamics methodology strives to capture.

The feedback loops can be portrayed quantitatively and solved to exhibit a trajectory for each element of the manufacturing system over time. Usually, the solution involves non-linear relationships that are intractable. Computer simulations or computations are therefore employed using a dynamic computer code called DYNAMO.[43] An example of such a code can be illustrated with a level equation.

$$O.K. = O.J. + (D.T.)\ (IM.J.K.-OM.J.K.)$$

Where O.K. = Industrial output at present time K

O.J. = Industrial output at the previous time of computation J

(D.T.) = The change that occurred at the time interval D.T. between successive computations

IM.J.K. = Inflow of material inputs during the J.K. time interval

OM.J.K. = Outflow of material inputs during the J.K. time interval

System Dynamics Modelling Process

Industrial dynamics should provide a basis for the design of more effective industrial and economic systems. An industrial dynamics approach to enterprise design and analysis comparises several steps among which are the following:

1. Identification of the precise problem or the system behaviour or the "Reference Mode" as it is called in system dynamics language.
2. Isolate the factors that appear to interact to create the observed systems.

42. Forrester, J.W., Urban Dynamics, (M.I.T. Press, Cambridge, Mass.) (1969).
43. Forrester, J.W. (1968), Principles of Systems (Wright-Allen Press, Cambridge, Mass.).

3. Trace the cause — and-effect information — feedback loops that link decisions to action to resulting information changes and to new decisions.

4. Formulate acceptable formal decision policies that describe how decisions result from the available information streams.

5. Construct a mathematical model of the decision policies, information sources, and interactions of the system components and the objectives of the model should be clearly spelt out.

6. Relevant or pertinent variables of the system should be chosen and the boundary of the system must be clearly defined.

7. Formulation of hypotheses of the interaction of the variables or causal loop diagramming should be accompanied by the selection of suitable parameters, that is, the level, rate and auxiliary variables and flow diagramming.

8. Generate the behaviour of the system through time as described by the model (usually with a digital computer to execute the lengthy calculations). This involves the writing of Dynamo Equations and the Simulation of the model.

9. Analyze the behaviour of the variables with respect to the reference mode or hypotheses. Results are compared against all pertinent available knowledge about the actual system.

10. Revise the model until it is acceptable as a representation of the actual system. Redesign, within the model, the organizational relationships and policies which can be altered in the actual system to find the changes which improve the system behaviour.

11. After the real system in the directions that model experimentation has shown will lead to improved performance.[44] System dynamics modelling possesses several merits over static models of industrial analysis. In constructing a system dynamics model, even before one runs it on a computer, one is compelled to fill in gaps of knowledge about the structure and parameters that specify feedback links. In simulating the system dynamics models, one often discovers new hypotheses or theories, unknown modes of behaviour could be uncovered, relationships among alternative theories, hitherto unknown will be established and appreciated while one can gain additional knowledge about whether or not a set of parameters needs further refinement. Above all,

44. See, Pugh III, A.L. (1970), *Dynamo User's Manual, M.I.T. Press* (Cambridge, Mass.).

the model will take account of changes in the environment (exogenous variables) that affect or influence the production behaviour, for example, of the manufacturing system.

Applications

The best known applications of the system dynamics have occurred in regional development analysis.[45] The application of system dynamics is not however limited to the analysis of regional economics. It has a wide application. Jay W. Forrester, applied this framework to analyze industrial and corporate management problems, as shown in his Industrial Dynamics.[46] He extended this methodology to the analysis of urban phenomena in his book Urban Dynamics.[47] Currently, the System Dynamics group at M.I.T. Cambridge, Massachussett is employing this framework to analyze the U.S. economy. It would be interesting to compare the results of Cobb-Douglas Production Function, a static model, with those of system dynamics based on dynamic relationships.

Summary and Conclusion

The problem of estimating the efficiency, behaviour or performance of industrial firms in any space economy is critical to resource allocation policies as well as regional or national industrial development planning and programming. Analysis of industrial behaviour with the use of static models can be harmful, yet no serious attempt has been made in Ghana and many developing countries to employ dynamic models for programming industrial planning and development. This exploratory paper is presented in the firm belief that it will open up debate on the potential usefulness of system dynamics methodology in analyzing industrial behaviour and efficiency, investment multipliers, employment generation, etc.

45. Hamilton, H.R., et al. (1969), Systems Simulation for Regional *Analysis, An Application to River-Basin Planning* (M.I.T. Press, Cambridge, Mass.).
46. Forrester, J.W., *Industrial Dynamics, op. cit.*
47. Forrester, J.W., *Urban Dynamics, op. cit.*

UNIQUE FEATURES OF THE PHILIPPINE MANGO INDUSTRY: 1. SMUDGING

by

N. D. BONDAD*

History

The Philippines has only two commercially-important mango cultivars, 'Carabao' and 'Pico', which are known for erratic flowering and fruiting habits. They usually flower naturally from December to January with some exceptions (Astudillo and Bondad, 1978; Dutcher, 1972). Harvest time, which comes 4 mo. after (Mendoza, et al., 1972), is in April and May when fruits literally flood the market making prices unprofitably low. Generally, the whole tree is not in bloom and, therefore, harvesting is partial. Flowering does not take place every year; and it is common to observe, especially in Southern Tagalog and Bicol Regions, trees that do not fruit at all although well beyond the bearing age.

The problem about mango flowering and fruiting must have been recognized many years ago judging from the early growers' practice of building smoky fires and allowing the dense smoke to pass through the foliage. This practice, called smudging, causes flowering.

It is not known who started smudging or where, when, and how it began. The statement of Dutcher (1972) and Barba (1974) that Wester (1920) was first to refer to the practice is incorrect. De Leon (1916) published an account earlier than Wester (1920). However, Gonzalez (1923) conducted the first scientific investigation on smudging although Lanuza (1939) claimed that F.G. Galang recorded it earlier. The latter himself gave priority to Gonzalez (1923). Along with Agati (Galang and Agati, 1936) he referred to a 1922 observation that by heating the ground under the tree by burning weeds and other combustible materials for eight times at intervals of a few days, twigs flowered. This work was unavailable for evaluation during the literature survey.

All the early workers failed to establish causative factors and this may, in part, be the reason for the general neglect of the pioneering efforts in this field by Filipinos. For example pineapple smudging, done in Puerto Rico by Rodriguez (1932), is listed as a milestone (Wittwer, 1971). It appeared about a decade after Gonzalez's (1923) first paper.

* Mr. N. D. Bondad is assistant professor, Department of Horticulture, University of the Philippines, College of Agriculture, College, Laguna, Philippines.

Inductive Effect of Smudging

In the earliest investigation of smudging, the author (Gonzalez, 1923) referred to the effect as "forced" flowering. Borja and Bautista (1932) were probably the first to introduce the term "induction" in relation to mango flowering with smudging. However, they had no evidence to support the use of the term. Their colleague (Lanuza, 1939) in the same institution also used the term "induction" and provided histological proof that there are no preformed floral characteristics before smudging. Similarly Dutcher (1972) observed that before smudging, both control and treated trees were entirely vegetative. He cited Alcala and San Pedro (1935) as having obtained dormant, vegetative buds prior to smudging. Dutcher (1972) went on to conclude that smudging actually induces mango to flower rather than simply causing preformed primordia to begin growth.

Heat. Gonzalez (1923) believes that flowering is due to the heat and not the smoke because the increase in temperature was directly proportional to the amount of flowers produced. Also, less intense heat requires longer period to bring about flowering.

Gonzalez (1933) further proved his heat theory by enclosing branches and twigs in waxed paper bags to exclude the possible affects of gases in the smoke. He also covered with test tubes other branches and defoliated twigs. He concluded that heat is the primary factor, not $C0_2$ or other products of combustion, because covered branches and twigs flowered. However, exposed branches flowered more than covered parts. Borja and Bautista (1932) did not agree because a tree 60 m away from the bonfire flowered as a response to stray smoke. Other related observations made them conclude that the smoke induces mango to flower.

Carbon dioxide and carbon monoxide. During smudging, an abundant amount of $C0_2$ is produced leading to an increase in photosynthates which, in turn, could favorably influence flowering. Galang and Agati (1936) conducted an experiment to test the role of $C0_2$ by supplying container-grown mangoes with precooled smoke. They concluded that both the presence of gases ($C0_2$ and C0) and a certain degree of temperature are essential for bud differentiation. Galang and Agati (1936) obtained little flowering in this experiment as well as in a follow-up trial (Galang and Agati, 1937).

Ethylene. Ethylene is among the gases in the smoke emanated by smudging materials (Pantastico and Mendoza, 1970). Early workers (Galang and Agati, 1936; Gonzalez, 1923) did not exclude the possibility of other components of the smoke being involved in the process of flower stimulation but failed to specify the role of ethylene.

Manuel, et al. (1971) were first to test the hypothesis that ethylene is involved. They did this by applying ethephon, an ethylene-releasing agent.

Ethephon was released for experimental testing as Amchem 66-329, ACP 68-250, CEPA, 2-chloroethanephosphonic acid, (2-chloroethyl) phosphonic acid, etc. in 1966. It is an important synthetic growth regulator which revolutionized the study of ethylene physiology. One reason for the long delay in recognizing ethylene as a hormone is the difficulty of demonstrating its effects because it is a gas that requires confinement when applied under field and laboratory conditions. Ethephon is water-soluble, an important virtue of this compound.

Manuel, et al's. (1971) work on ethephon commenced in 1968. They wrote a paper which I saw and cited as "in press" (Bondad, 1972; Bondad, 1976) although it never appeared in print for an undetermined reason.

Dutcher, et al. (1971) were first to publish a report on the flower-inducing property of ethephon on mango. Indian workers also published numerous experiments including one (Chacko and Randhawa, 1971) which appeared in the same year as Dutcher, et al's. (1971) paper. The authors (Chacko and Randhawa, 1971) acknowledged having communicated with R.D. Dutcher.

One may not be content which attributing the flowering effect on mango of ethylene when actually ethephon was applied. The issue that ethylene indeed has flower-inducing property on mango should end with the report of Dutcher (1972) that the gas, released from an ethylene tank, induced mango flowering.

Acetylene. This is among the gases detected by Pantastico and Mendoza (1970) from burned smudging materials. Dutcher (1972) found that it could induce mango flowering. A little-known practice is the application of calcium carbide through holes made on trunks to induce mango flowering. Calcium carbide ("kalburo") releases acetylene upon contact with water.

Producing the Smoke

Borja and Bautista (1932) defined smudging as a suffocating smoke produced by a low-burning bonefire. The universal practice in mango smudging, however, is to make the first smudge big and hot (Gonzalez, 1923). This can be accomplished by igniting a large pile of readily combustible material. To produce the dense smoke, the burning pile is covered generally with freshly cut vegetable matter although most other relatively fresh plant parts are suitable. The dense smoke may also be obtained by burning relatively wet rice hull. Dutcher (1972) described the use of this material which is practiced in very large scale. Long before (7 to 8 mo.) the process begins (October to December), carloads

of rice hull and "talahib" (**Saccharum spontaneum** L. ssp. **indicum** Hack.) are hauled and stacked at convenient points in the orchard. These materials absorb moisture and partly decompose as the rainy season passes by. The moist rice hulls burn more slowly and produce more smoke than freshly-threshed ones.

Duration

The fire is kept for 12 h or, if quick results are desired, for 24 h (Gonzalez, 1923). When the latter is practiced the fire is heavily banked at night with moist rice hull producing a slowly smoldering fire for a large part of the night (Dutcher, 1972).

Usually, 2 wk of daily smudging is adequate and the process is stopped shortly after the appearance of the first flowers. If no flowers appear smudgers may stop, work on other trees and come back for the 2 wk cycle (Dutcher, 1972), or continue for another week and completely drop the trees for the season's operation (Gonzalez, 1923). According to Borja and Bautista (1932), trees that do not flower after 14 d of continuous smudging will not flower at all.

Selection of Trees

A tree, Gonzalez (1923) stated, is ready for smudging if the leaves are dull-green, greenish-brown, or almost copper-colored; and terminal buds are dormant but plump or well-formed. More careful smudgers employ additional criteria. They judge trees to be suitable when all vegetative growth stops several months earlier. Trees that still have recent growth, such as those with 2.5 to 5.0 mo old shoots, do not respond to smudging (Galang and Agati, 1936). The leaves of suitable trees are dark bluish-green, brittle, and could be crushed easily in the hand. Dutcher (1972) added that buds are of good size and tightly enclosed by bud scales, indicating a dormant condition.

Smudging Materials

The commonly used smudging materials are broadleaf weeds, grasses, rice hull, rice straw, trunks, branches, twigs, shrubs, crop leftovers, and parts of pruned or fallen mangoes themselves. Where these are scarce, household waste, old newspaper, old rubber tire, firewood, and almost any combustible material are used. However, a certain amount of relatively fresh vegetable matter, generally weeds, is essential. In Bulacan some growers use leather trimmings ('katad") to smudge mango (Bondad, et al., 1979).

Time to Smudge

The time to smudge is usually dictated by the weather conditions. Smudgers begin the operation about a month or two before the normal flowering season and following a few clear, bright or sunny days. Calm

weather conditions occur in October the latter part of which smudgers consider as among the best time to smudge, the others being the whole of November and early part of December. Gonzalez' (1923) findings tend to confirm this. However, Borja and Bautista (1932) obtained the best results in January.

Gonzalez (1923) concluded that smudging can be successfully carried out anytime of the year, despite the absence of flowers in June-July. He attributed this, and the sparse flowering in August and September, to heavy rains which often or repeatedly put out the fire.

Cultivars Tested

The Philippine mango cultivars Carabao and Pico are very responsive to smudging under appropriate conditions. Alcala and San Pedro (1935) reported the only trial on foreign cultivars. One of two unidentified Indian mangoes they used did not respond while the other flowered. A work in India (Sen and Mallik, 1947), cited by Sen, et al. (1973), was unsuccessful. No other report has been published abroad although Chandler (1958) mentioned it being done in Indonesia. Dutcher (1972) is of the opinion therefore that smudging is a unique feature of the Philippine mango industry. Carabao mango is grown commercially in Mexico where it is called 'Manila'; it is well-known to respond favorably to smudging; Mexico and the Philippines had a long period of association while under the Spanish rule from the 16th to the 18th century; and smudging is believed to date back to the Spanish era in the Philippines (Lanuza, 1939). It is thus possible that Mexican growers also practice smudging. However, no report has been encountered in the literature. If smudging is indeed practiced there it is likely to remain unique to mangoes of Philippine origin, particularly 'Manila' which is a selection of the Carabao race (Bondad, et al., 1984).

Advantages and Disadvantages

Lanuza (1939) considered smudging very expensive about half a century ago. In the absence of innovations or improvements in the technique, smudging remains very expensive in recent years that it was still in use. The expenses largely go to labor. Additional expenses are incurred where smudging materials are purchased. An owner of a large farm actually plants weed seeds.

The high labor requirement of smudging may not be a disadvantage altogether under Philippine conditions. There is abundant family labor; substantial idle manpower is available in many mango-growing areas; and labor cost in the Philippines is relatively cheap. That smudging is unreliable is not supported by published experiments. In 1978 growers have practically abandoned smudging with little evaluation of its merits.

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IMPROVING TRANSPORT SERVICES AND FACILITIES IN THE DEVELOPING AREAS — EVOLVING STRATEGIES FOR OVERLAND TRANSPORT SYSTEM IN NIGERIA

by

KRYS OCHIA*

ABSTRACT

Improved access within nations of developing countries is necessary for improvement in social and economic conditions. Improved overland transport and public sector commitment to mass transit are needed policy actions. In some of these nations including Nigeria, it appears available road space is dwindling in the face of increasing human activities despite committed resources. Alternatives are examined here which would involve both public and private sector actions for upgrading transport services and facilities.

ACCOUNTABILITY

One of the major public sector problems associated with providing transport services in Nigeria is accountability which directly affects program/project output. The federal Nigerian government has been allocating the highest percentage share of total national public capital expenditures to transportation during its pentannial Plan Periods: 22.5% (1962-68 Plan); 21.0% (1970-74 Plan); and 33.18% (1975-80 Plan), and for developing and developed countries, the share of transport and communication has averaged between 20% and 25% (Bejakovic, 1970). In Nigeria, however, program/project output for road kilometrage completed/improved, bridges constructed/rehabilitated, public information disseminated regarding road usage or the number of new transit services established, etc., may not positively correlate with fund allocation. In the Western State, for example, between 1961-71, total road kilometrage maintained by all public authorities was declining while total expenditures were increasing (Table I). And between 1964/65-1966/67 while total road kilometrage maintained remained unchanged, road maintenance costs rose by 80.7%, even though consumer price index rose by no more than 25%.

* Mr. Krys Ochia is a researcher in transportation and is affiliated with Portland State University, Oregon, U.S.A.

TABLE 1. KILOMETRAGE OF ROADS MAINTAINED AND MAINTENANCE COSTS IN THE WESTERN STATE OF NIGERIA, 1961/62-1970/71.

Financial Year	Road Kilometrage Maintained	Expenditure on Maintenance, (₦)
1961-1962	16,862	813,000
1962-1963	17,331	942,000
1963-1964	14,173	764,000
1964-1965	15,373	724,000
1965-1966	15,373	796,000
1966-1967	15,373	1,308,000
1967-1968	15,602	1,202,000
1968-1969	14,822	1,022,000
1969-1970	14,848	1,400,000
1970-1971	14,893	1,400,000

Source: Adapted from Western State of Nigeria, Statistical Abstract, June and December, 1970.

The inverse relationship between road maintenance costs and road kilometrage maintained is a strong reason for suspecting massive waste in resources with its attending negative impacts on improving economic conditions and quality of life (Ram, 1982).

Generally, local authorities in Nigeria are responsible for more road kilometrage than federal and state governments combined (66.7% in 1972) but have the least resources — expending about 3.2% of total national expenditures.

One important element is the method used in disbursing appropriated funds in which there are no guidelines for public accountability. Often, policy makers who may also be prime policy administrators are not held accountable for policy outputs. A pragmatic solution would require the creation of a federal agency responsible for monitoring and periodically or summatively evaluating federally funded programs in concert with affected state and local authorities. Such agency should be answerable to the legislature (or the Supreme Military Council). Similar agencies would also be created at the State and Local levels and answerable to appropriate authorities. An effective evaluation system would make administrators more responsive regarding program efficiency and effectiveness. Moreover, present intergovernmental relationships fail to provide a proper framework for responsible tri-lateral participation in transportation-related decision processes. Especially important is the total eclipse of local businesses and community leaders in formulating policies which impact local businesses and community residents. Perhaps, a mutually developed national, state and local Transportation Master Plans would provide articulate framework, if such plans are periodically updated.

There is also the need to develop an urban hierarchy in funding transportation programs. The urban centers continuously enjoy preferential treatment to the detriment of other areas. Perhaps, a decentralization of selected federal ministries, other than a mass movement to the new capital at Abuja, and with the country divided into planning regions, would benefit the often-neglected towns and rural settlements, improve interagency communication as physical distance is reduced, improve cooperation and ultimately foster efficiency.

MASS TRANSIT AND TRANSIT FUNDING

There is the need for the public sector to show more concern in providing mass transit since a large percentage of the population is transit dependent. Transportation funds are utilized to acquire passenger planes, and caboose and cars for trains. Although such capital investments may be beyond the means of many private investtors who could more easily purchase trucks or buses, yet, it does not preclude public commitment toward mass transit services. Eventhough per capita auto ownership may be rising, 0.7 auto/1000 persons in 1958; 1.0 auto/1000 persons in 1970, and 2.0 auto/1000 persons by 1980, per capita income is still very low — $380.00 in 1979. Table II shows the national auto ownership trend and total road kilometrage since 1950.

TABLE II. NATIONAL AUTOMOBILE OWNERSHIP AND ROAD KILOMETRAGE IN NIGERIA FOR SELECTED YEARS, 1950-1977

Year	*Road Surface (Total Km.)*	*Number of Operating Automobiles*
1950	17,340	13,200
1955	35,690	28,300
1960	41,060	50,700
1963	35,305	68,000
1965	55,540	56,790
1970	57,340	97,000
1973	55,320	232,000
1977	65,000	—

Sources: Nigeria: Annual Abstract of Statistics, 1960, 1970, U.N.: Economic Survey of Africa, 1978.

Between 1970 and 1973, auto ownership increased by over 130% while available road declined by 3.5%. The 1950-55 period appears to witness the highest growth (105.8%) in available road while the post-independence period (1960-63) recorded the highest decline (14.0%) in available road. The federal government banned auto advances for public employees (1979) but has yet to formulate national policies for encouraging mass transit. Apart from localized subsidizes for van pools and

transport allowance, there has been no appreciable commitment toward improved national mass transit programs. Small scale operators dominate the mass transit industry providing a lower threshold of needed transit services. There are incidences of passengers scrambling to board buses, load factors up to 180% with passengers hanging on sides of buses. Moreover, significant proportion of areas and population are without services, especially areas outside the "spread-effect" of urban areas. For routes where services may exist, the carriers may usually find it inexplicable to consider contributing toward upkeep of locally-built roads. The degree to which such local roads deteriorate decreases with increasing distance from a major urban area. However, for inter-urban operators striving to reduce operating costs by detouring through local communities without necessarily providing them services, the distance-deterioration curve becomes horizontal.

Mass transit is not subsidized in Nigeria. Although the author does not argue for levels of subsidy in many developed countries, as in Europe where "subsidies ranged from 10 to over 70% of total transit costs in 1975; (even), ... the trend appears to be toward ever increasing subsidization of public transportation" (Giannopoulous, 1980), yet, it would be appropiate for decisive government sponsorship for inter-urban and urban-non urban mass transit services. There may be a tendency to argue that since ridership may be low and perhaps cyclical with attending high opportunity costs, it is cost-effective not to extend services to rural areas, including building all-weather roads. An acceptance of such logic would translate to rural areas "permanently" remaining rural, thereby confirming an expert's doubt of achieving any significant improvement in the life-style of many poor Nigerians in a long run (Okedeji, 1977).

But, between 1967 and 1969, the author observed the economic activity focus of a village gradually shift next to a new major access which provided dependable (overland) transport service. The change in access pattern elevated the settlement's local economic status since it began to serve as a daily market for exchange and distributing center for local foodstuff and other merchandise. Although the evidence may be inconclusive, yet, it may be safe to state that if the inhabitants of a rural area realize a transportation service is continuously available, change in travel behavior may occur resulting to increase in patronage. Generally, there are externalities including decline in human porterage to a more distant market, increase in the quantity of food available at the market and a spatial increase in local economic activities. In terms of improving mass transit, the following is considered:

— Creation of a special transportation fund, a National Road and Highway Development Fund, or HR-FUND, by strengthening existing revenue sources and evolving new methods specifically for road and highway construction and or maintenance. They

would include revised petrol (gasoline) sales tax, drivers' license fees and truck operating fees, especially when some of them service landlocked adjacent countries and since trucks and other heavy vehicles usually inflict more road damage than lighter automobiles (Forkenbrock, 1984). A World Bank Mission to Nigeria also confirmed that heavy trucks are the worst offenders in failing to contribute to highway costs (World Bank, 1974). Table III shows data on such vehicles since 1974.

TABLE III

Year	*No. of Agricultural Lorries Registered in Nigeria*
1974	1,134
1975	2,284
1976	4,743
1977	4,391
1978	4,641
1979	2,160
1980	3,171
1981	3,833
1982	2,743

Source: Business Concord, June 1983.

Although economic conditions contribute to zig-zagging of the numbers, a total of 29,100 articulated lorries were registered in Nigeria over a period of nine years. The cumulative effect, after accounting for losses due to accidents, etc., on the badly constructed and maintained roads on worsening road conditions would mean increasing freight and related costs which indirectly affect economic activities due to increasing total transport costs. Also, auto sales tax and annual registration fees should be periodically revised upwards to reflect increasing construction/ maintenance costs. Some form of these charges may currently exist but their haphazard administration qualify them for reevaluation.

Finally, Transit Districts could be created within each Planning Region to offer services to residents. As private carriers tend to concentrate services on high density corridors, public sector sponsored transit services along the not-so-profitable corridors would in addition improve total access pattern as public funds are used to improve roads for government fleet thereby making the route attractive to other providers. A trade-off would be the dampening private carrier desire toward the usual unprecedented fare hikes characteristic of peak holiday seasons, as a more spatial distribution of services is achieved.

PRIVATE/PUBLIC CO-OPERATION

There is a need for structured citizen input in formulating transportation policies and programs. The author is proposing amendments to the Indegenization Program by introducing an Area Development Fund, FAD, into which businesses would contribute to and the funds utilized for upgrading transportation services in areas they do business. This would provide a forum for joint public-private co-operation in evolving needed transport programs for target areas.

Another option includes the institution of a supplemental inter-city rail passenger services along high traffic density travel corridors with private sector participation. The Lagos-Ijebu Ode-Asaba-Onitsha-Owerri-Aba corridor with branch services from Onitsha to Enugu and between Lagos and Ibadan comes to mind — it has one of the highest population densities in Africa outside the Nile Delta. The acquisition of needed modern technology should include buying training for local personnel and retaining expatriates until appreciable local manpower is developed; delivering the vehicles after extended testing in operating conditions similar to local environments; and dealing only with contractors with proven track records. With a potential high occupancy rate per mile of rail cars, such a service would contribute in reducing the high density highway traffic thereby reducing the high auto accident rate associated with the corridor.

Organized labor and its leadership is another source. Such transportation-related unions include Motor Park and Taxi Drivers' Associations. Co-optation at the local levels affords a tremendous unutilized resources. At the national level, Kilby has discussed union history including employee-employer relationships and formation of splinter groups (Kilby, 1969). But Waterman's work provides basis to infer the Registrar of Unions could effectively limit the number of such unions which the minister (of Labor) would recognize (Waterman, 1980). With an appropriate number of such associations, the government could begin to formalize communication channels. Union leadership and the government, less union incorporation into public administration, could begin to formulate pricing policies for transit services. Also, the random location of motor parks or passenger loading stations could be controlled effectively. Furthermore, plans could be developed for scheduled clean-up of existing motor parks, rather than relocating them to outlying parts of town (Vagale, 1971). Under such mutual relationship, effective route allocation could be attempted with union leadership participating in its enforcement. Color codes could be utilized on vehicles for designated routes. Finally, a liaison between the government and the large mass transit operators, if established,

would create a forum for exchanging ideas on over-land transit problems and for devising strategies for solution. The opportunity would be utilized to promote awareness on the private sector for the necessity of effective contribution for the upkeep of the road system.

TRAFFIC REGULATION

Effective use of police power in enforcing traffic laws and regulation should constitute a high priority. The model free-enterprise road transport system in Nigeria does not necessarily mean freedom from prevailing traffic ordinance. Moreover, the use of para-traffic officers to control and enforce traffic rules in certain urban centers including Lagos may be counter-productive as motorists may even fail to accept them as "true" representatives of authority.

The quality of Nigerian motorists could be improved through government reevaluation of operating driving schools and corresponding revamping of driver licensing program by use of stricter procedures so as to produce informed vehicle operators knowledgeable about traffic laws and regulations.

Finally, it is even feasible to create auto free zones at selected economic activity foci of targeted urban centers were accessibility is becoming very difficult. Such measure would improve pedestrian circulation. An important factor here is to pursue such policies with full participation of local governments, businesses and developers.

Concluding, it should be realized the foregoing is not comprehensive in view of present economic conditions. However, it represents alternatives for continued policy debate regarding actions for improving transport services to human activity centers, public services and facilities.

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METRO MANILA, A 'MEGA CITY' BY THE CENTURY'S END

Manila — (DEPTH news) — Metro Manila will attain "mega city" status 15 years from today or in 2,000, according to National Census and Statistics Office (NCSO) projections.

Mega city is defined by demographic experts of the United Nations Fund for Population Activities as an urban center with a population of 10 million or more.

NCSO's projection is based on an estimated 200,000 yearly increase in number of residents in the four cities and 13 municipalities which constitute the Metro Manila area.

Metro Manilans were estimated by NCSO to have counted at 6.8 million as of end 1984, compared to 6.6 million in 1983 and 6.4 million in 1982.

The government agency said it uses the middle assumption method in projecting the growth of Metro Manila's population based on the 3.58 percent annual increase measured during the 1975-1980 period.

It said the city area's population was enumerated at 4.9 million by the 1975 census and at 5.9 million by the 1980 census.

Of the four Metro Manila cities, residents of Manila proper and Quezon City are now well over the million mark, while those of Pasay and Caloocan cities are still below half a million, NCSO said.

The agency's projection that Metro Manila will become a mega city in year 2000 dovetails with that rendered by Bangkok-based UN Economic and Social Commission for Asia and the Pacific (ESCAP).

ESCAP reported that Metro Manila and 14 other Asian cities will count among the 25 most populous urban centers or mega cities of the world by year 2000 which is just 15 years from today.

The 14 others are listed by ESCAP as Shanghai, Tokyo, Beijing, Bombay, Calcutta, Jakarta, Bangkok, Seoul, Madras, Karachi, New Delhi, Tehran, Osaka-Kobe and Dhaka.

ESCAP said a demographic survey of the region it conducted in 1984 showed that the urban population increased by 26.4 percent during the 1980-1983 period from the 23.4 percent growth rate recorded in 1970.

The UN agency said the steady rise in the region's urban population is shown by the records: in 1970, only nine Asian cities were among the

25 largest urban centers of the world, the number increased to 12 by 1980 and is projected to further rise to 15 by year 2000.

Such growth in city population means that the "deterioration in conditions of urban life and the burden of providing amenities will be major problems for governments in the region" in the years ahead, ESCAP said.

The survey found that rapid rise of urban populations in the region was principally due to migration of people in the rural areas to the cities in search of better jobs and living conditions.

ESCAP said the pace of city population increase has not been matched by urbanization or the provision of basic amenities, thus giving rise to squatter colonies and slum areas whose residents suffer wretched living conditions.

However, the survey also noted that several governments in the region have been successful in moderating inflow of rural residents to the urban areas. One example is that of the Philippine government which provides free transportation back to the rural areas.

South Korea is identified by the ESCAP survey to have posted the highest urban population growth rate at 5.1 percent between 1980-1983 with Iran second at 2.7 percent.

Urban growth rates for the Philippines, Malaysia and India during the same period were measured by ESCAP at 1.3 percent; Indonesia, 1.9 percent, Thailand, 0.7 percent, and China, 0.4 percent.

Based on such an expansion of the urban population in the region, ESCAP said 20 million households are projected to live in "absolute poverty" in Asian cities by year 2000.

The Asia-Pacific population now constitutes over half of the total global population and has a yearly growth rate of 1.7 percecnt, ESCAP said. It added that in 1983, the additional population was estimated at 44 million or nearly twice that of the combined population of Australia, New Zealand and the Pacific Island countries.

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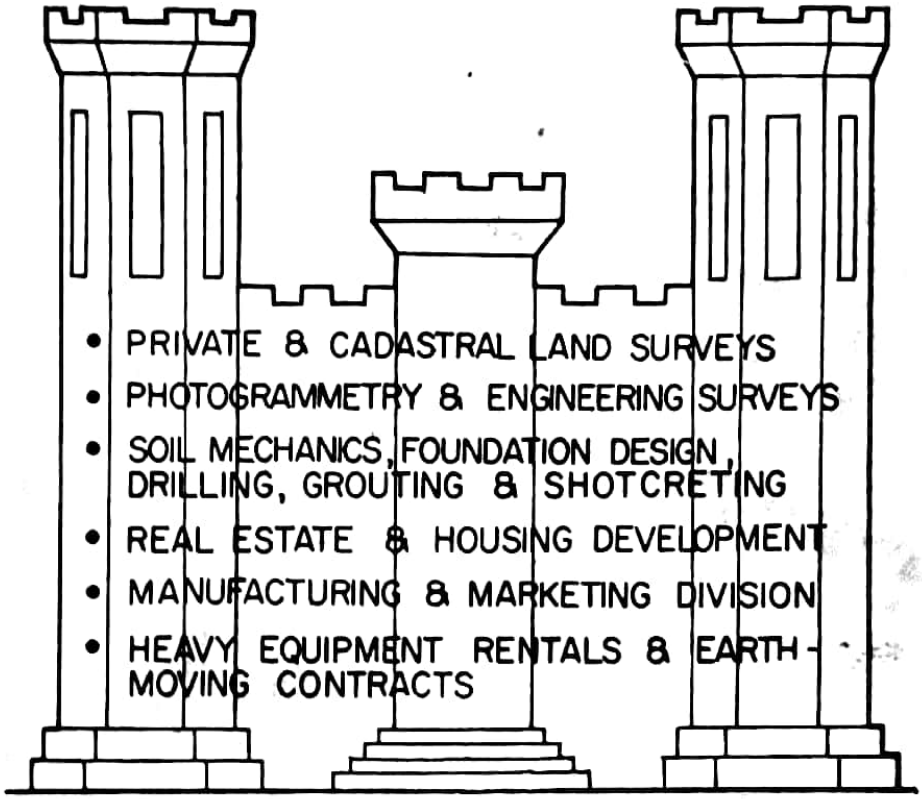
[1] Reprinted from the newspaper *Malaya*, April 8, 1985, page 2, Metro Manila.



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