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D 04544

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.132/11
9 January 1973

ORIGINAL: ENGLISH

Seminar on Stimulation of Industrial
Research in Developing Countries

Singapore, 21 November - 4 December 1972

REFLECTIONS ON INDUSTRIAL RESEARCH IN THE DEVELOPING COUNTRIES OF ASIA AND FAR EAST[1/]

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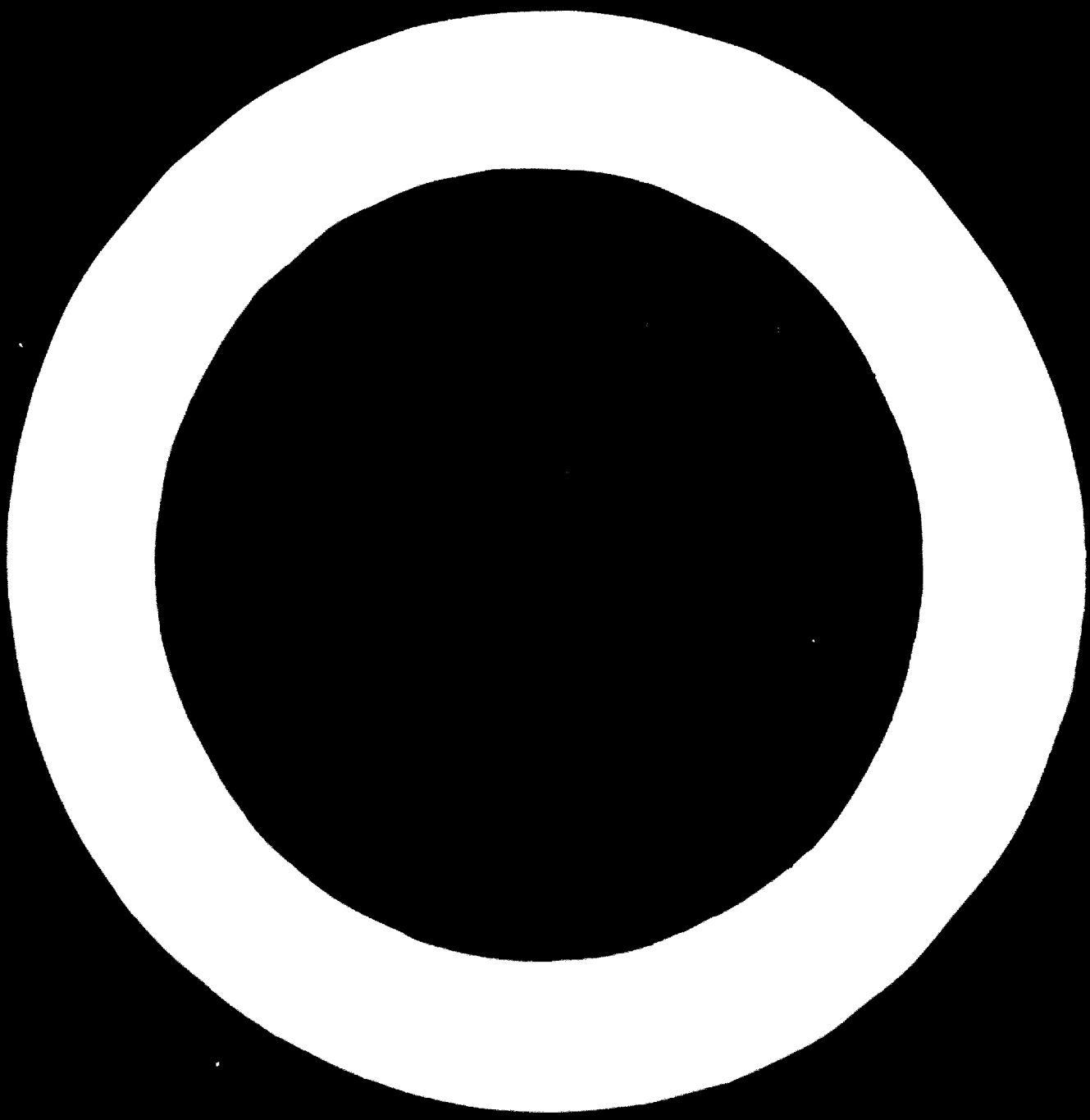
id. 73-0162



The countries of the Asian and Far East region with the exception of Australia, Japan and New Zealand are termed, for want of a kinder description, 'developing countries'. Prior to 1950 these countries were and some still are basically producers of primary products from agriculture, others were engaged in shipping out their life blood in the form of non-renewable mineral resources. The two exceptions are Hong Kong and Singapore both without any agricultural or mineral resources but with a tradition in entrepot trade.

Industrial development was very low prior to 1950 and The annual average rate of growth in the manufacturing sector during the period 1938-1948 was less than 1 per cent excluding Japan. Ironically enough it was the advent of the Second World War which brought in the primary stages of industrialisation. The breakdown in the flow of consumer goods from Europe and the needs of the war effort in the region had to be met by local production. Thus emerged a very small industrial sector. This was to be further enhanced by the attainment of political independence of many of the countries in this region and the planned development of a broad based industrial sector in their development plans. In the period 1950-1960 the average annual rate of industrial growth had risen to 5 per cent for the region excluding Japan.

It is to industrialisation that the emergent nations of Asia looked for self sustaining growth. The desi ability and economic necessity for industrialisation has never been in dispute. What has been under debate are the strategies of development, the structure of the growth rates, the nature of production and distribution of wealth and the necessary instruments for achieving accelerated industrial development and high growth rates.

Thus emerged in the first Development Decade (1960-1969) a change in the structure of production and exports in which industry was to play an increasing and dominant role. Industrialisation became a crusade of our times. This belief was expressed by Prime Minister Nehru when he said "Real progress must ultimately depend on industrialisation". Such expectations in industrial development required certain essential elements for success. In the experience of the developed countries one such element was the transfer of technology and the ability to innovate provided by what is now termed industrial research.

In the period prior to the forties industrial research and the advancement of science were considered to be synonymous. It is only in the last two decades from accumulating experience of many countries that the subtle differences are becoming apparent.

The primary purpose of industrial research is to secure and maintain through technical innovation a high rate of productivity in the manufacturing sector of industry. It does not attempt, except in rare cases, to increase the body of scientific knowledge.

Industrial research is no test tube affair but a practical exploration into industrial development through all phases from micro-planning, research, pilot plant studies and development to production itself. The functions of industrial research are to create the necessary technology required for use of a particular raw material specific to a country on which no known technology exists; to adapt or modify imported technology to suit particular resource patterns in the country; and to maintain the adapted or created technology at maximum effectiveness in industry.

The creation of a technology does not stop with discovery. This is only a beginning based on bench scale experimentation. The systematic use of knowledge in increasing scales of output to near manufacturing scale and termed "development" is a necessary step if the technology is to be sold. Development includes modification to plant and machinery, design and construction of plant on a scale where variable costs, variable wastage and other factors could be evaluated. Transfer of a new technology to local industry requires a visual demonstration of the process on near manufacturing scale together with full detailed information on

machinery, product design, materials, process engineering, unit cost, and profitability. These same considerations will apply perhaps to lesser extent to an adapted technology or a modification to a machine. Often entrepreneurs would require assurances of continuous assistance in testing, trouble shooting, process control, machine maintenance, industry information, product design, layout and similar aids to production. These are essential elements of service if research results in this region are to be extended to production and accelerated industrial development is to be achieved.

In the asian region much of the work of industrial research institutes has emphasised resource surveys and bench scale studies on the utilisation of indigeneous raw materials. The main shortcomings are, the inadequate involvement of engineers in 'development' work with consequent poor transfer of technology, the lack of effective liaison and extension services to industry and the lack of well formulated and evaluated programmes of research designed to meet established and planned needs. A national research institute can only play an effective role in national development if it provides the right technology of the right amount at the right time. To this extent it needs to be in the hub and counsel of overall planning. A brief survey of the industrial research facilities is provided in order that we might discuss how the research institutes in this region have fulfilled their functions and expectations of the countries they serve.

The only countries where industrial research effort is completely absent in this region are Afghanistan, Khmer Republic, Laos, Nepal and the Republic of Vietnam. In Hong Kong industrial research has not still been institutionalised but H.K. Technical College undertakes design of machines and moulds and the Federation of H.K. Industries has a school of industrial design.

The two pioneers in Asia are India and Pakistan. The Council of Scientific and Industrial Research in India was established in 1947 with Prime Minister Nehru as its Chairman and guide. Its rapid growth will be seen in the 29 National Laboratories, several cooperative research organisations and three regional laboratories. The Central Design and Engineering Institute was established in 1963 which in conjunction with well equipped workshops in the research institutes has made possible the development of a number of processes utilising local raw materials and their acceptance by Indian industry.

The Pakistan Council of Scientific and Industrial Research was established in 1953 with 7 central laboratories and several regional laboratories in the East, West and North. An Industrial Research and Development Centre was established in East Pakistan during the second plan period (1960-1965). A privately endowed institute the Fasl-q-Omar Research Institute founded with the object of promoting the study of science and development of industries has existed since 1926. All other research institutes are organised as governmental institutions but regarded as productive functional parts of the country's industrial development facilities.

Two other countries - Indonesia and Philippines also established a spectrum of research services to industry. In Indonesia a number of institutions existed long before independence such as the Textile Research Institute founded in 1922, the Leather Research Institute founded in 1913, the Materials Research Institute founded in 1929. A number of research institutes were established since independence such as the Ceramics Research Institute in 1961 and the Batik Research Institute in 1949. In 1956 a Council of Science was established and it has since established a number of laboratories in specialised fields including metallurgy and electronics. The dual responsibility between Government agencies and the Science Council has resulted in poor liaison with the industrial public and meagre developments of research results to production.

In the Philippines a Science Act was enacted in 1958 which created the National Science Development Board (NSDB) and expanded the old Bureau of Science into the National Institute of Science and Technology (NIST) with eight technical operating units, the biggest of which is the Industrial Research Centre with sections devoted to chemistry and engineering. There also exists a Government Agency named the National Development Company which has research functions.

The multipurpose industrial research institute dealing with a variety of industries and a wide spectrum of services came into existence in Burma with the establishment of UBARI in 1954, in Taiwan with the establishment of the Union Industrial Research Institute (UIRI) in 1954 and in Ceylon with the establishment of the Ceylon Institute of Scientific and Industrial Research in 1955. Based on this experience Korea established its Korean Institute of Technology (1966), Thailand its Technological Research Institute (1963), Singapore its Industrial Research Unit (1963) and Malaysia its National Institute of Scientific and Industrial Research (1971). Two countries have, effectively combined Standards and Industrial Research. Iran established its centre for industrial research within an older standards and testing organisation in 1960. Singapore incorporated standards into the Industrial Research Unit to form the Singapore Institute of Standards and Industrial Research.

Many of the countries which preferred the multipurpose type of industrial research institutes also have other specialised institutes. Malaysia has the Wood Technology Research Centre, the Minerals Research Laboratory, and the Rubber Research Institute. Singapore has a number of units under the Economic Development Board such as the Engineering Industries Development Agency, with several sub-departments devoted to specialised fields. In Taiwan the work of UIRI is supplemented by five other research institutes in specialised areas such as sea products and aluminium.

In Thailand the Department of Science serves as a government central laboratory and a scientific centre in addition to the Technological Research Institute. The Department of Science has undertaken several industrial research projects and has in recent years increased its facilities and capability with expansion of the Division of Biological Sciences and the Division of Physics and Engineering. Korea, Burma and Ceylon appear to be the only countries where the multipurpose institute has sole responsibility for industry.

This survey had to be brief because of my own limited experience in only two countries but this will be remedied I feel sure by the country reports. These are expected to provide fuller accounts of the institutional framework for industrial research with case histories of projects and problems solved. The purpose of this seminar is to exchange experiences and to find solutions to common problems and I hope that these country reports will reflect not only successes but vexing failures as well.

In the absence of that mine of information I have been forced into the position of a devil's advocate. As an Asian and a former Director of an industrial research institute in this region I may be forgiven for playing this role. We are not gathered here to pay ecomiums to each other but as true scientists to make a critical analysis of our achievements and failures, to

understand constraints and limitations to our roles, and thereby to improve our contribution to development of industry in Asia.

I propose to initiate this soul searching with presentation of some data related to industrialisation and research effort in selected countries. The annual average industrial growth rate for Asia and Far East excluding Japan rose from 1 per cent in 1938 - 1948 to 5 per cent in 1950 - 1959. During the first Development Decade (1960 - 1969) most of the countries increased their average rate of industrial growth. The rate has varied from country to country: in Iran, the Republic of Korea, Malaysia, Taiwan and Thailand it exceeded 10 per cent; in Ceylon, India, the Khmer Republic and Pakistan it ranged from 5 to 10 per cent; in Burma, Indonesia and the Philippines it was less than 5 per cent.. Perhaps these figures are deceptive as the rate of growth is a factor of the industrial base in 1959. Also there could be other factors like the oil finds in Iran which raised the manufacturing component of its GDP to 37 per cent in 1969 in spite of the meagre facilities in industrial research services in that country. It is perhaps more satisfactory to look at the actual contributions by the manufacturing sector to the GDP in 1960 and 1969 shown in Table 1. It should be remembered that Indian industry was already ahead of many of the countries in this region by 1950 with well established textile, steel and metal industries. Also, industrialisation and transfer of

9. (a)

TABLE I

DATA ON GDP AND MANUFACTURING FOR ECAFE COUNTRIES
(in millions of US dollars)

COUNTRY	Population (millions)	GDP in millions US$		Manufacturing in millions US$				Per Capita in US$
	1969	1960	1969	1960	% to GDP	1969	% to GDP	
CEYLON	12.2	1,299.2	1,913.9	65.7	5.1	200.1	10.5	137 1/
INDIA b/ g/	537.0	31,652.2	41,051.3	4,475.7	14.1	6,972.7	17.0	73 2/
INDONESIA	116.0	3,185.3	4,149.4	266.1	8.4	389.4	9.2	68 2/
IRAN	27.9	4,473.9	9,380.9	393.4	8.8	3,695.0	39.4	252 2/
KHMER REPUBLIC d/	6.7	791.4	914.3	68.6	8.7	94.3	10.3	119 4/
KOREA REPUBLIC OF g/	31.1	2,973.8	7,110.8	394.6	13.2	1,850.8	26.0	163 2/
MALAYSIA (West) d/	12.1	1,676.1	2,361.4	140.9	8.4	263.7	11.2	254 5/
NEPAL f/ d/	10.8	486.8	934.1	59.1	12.1	100.1	10.7	66 2/
PAKISTAN g/	111.8	7,687.1	12,596.2	757.2	9.8	1,515.7	12.0	131 1/
PHILIPPINES h/	37.2	4,487.3	7,080.9	805.3	17.9	1,209.7	17.1	283 1/
SINGAPORE g/	2.0	668.6	1,806.7	59.9	9.0	370.6	20.5	756 3/
TAIWAN		1,793.9	4,016.2	310.5	17.3	964.6	24.0	-
THAILAND	34.7	2,691.8	5,395.0	351.4	13.0	886.0	16.4	126 2/
VIETNAM REPUBLIC OF g/	17.9	2,097.1	6,131.4	225.7	10.8	414.3	6.8	148 3/

Source: - ECAFE Secretariat.

a = 1967
b = Fiscal year beginning 1 April
c = 1968/69
d = 1966
e = 1970
f = GDP at current factor cost
g = Fiscal year beginning 1 July
h = Net domestic product

1 = 1969
2 = 1968
3 = 1967
4 = 1966
5 = 1964

technology can proceed without the intervention of the local research institute such as by the use of consultants, foreign collaboration with built in know-how and expertise, licencing and know-how through patents and trade marks, turn-key projects, and the import of complete plants with initial skilled help. These however resulted in a repetative import of technical know-how for the same item. In consequence, the control and direction, and transfer of technology have mostly remained with the sources from which they were imported. It has been reported that the annual cost to Pakistan of foreign consultancy and related services has amounted to US$100 million and the cost to India, about US$333 million. It would be revealing to study the figures for Taiwan, Korea, Philippines, Singapore and Malaysia where a large number of industries have been set up in recent years.

These considerations suggest that industrial development can take place although at a price without the assistance and support of an indigeneous source of technology. It is too early to prognosticate on the price paid and the deleterious effect on the structure of industrial production. It is often the prestigious and luxury articles which are considered for outside support like cars, air-conditioners, TV and radio, not those essential to human needs. These only underline the need for indigeneous industrial research in order to provide competent advice to the local entrepreneur and the Government agencies

on joint projects in respect of the choice of technology, licencing, know-how transfer, training and also on the type of products to be manufactured and raw materials to be used. Such involvement from the outset is the best guarantee that imported technologies and know-how will be absorbed within the research and development framework and be available for adaptation and use in the country.

The choice of technology, its adaptation and appropriateness to the resource patterns prevailing in the developing countries and the new field of activity termed appropriate technology has attracted much attention and study. The choice of technology is an attempt to find the optimum combination of the factors of production, maximising resources in abundance and minimising on scarce resources. For the developing countries of Asia it would involve the intensive use of the more abundant resources such as labour and indigeneous raw materials, while economising on scarce resources such as capital and skills. The technology of the industrialised countries is developed to suit a different pattern of resource availabilities that of abundant capital and shortage of labour. Consequently the imported technology is labour saving and capital intensive. The use of such technology in Asia without suitable adaptation can, in cases, even be harmful. Consequently some adaptive research becomes necessary. Such research involves modifications either to reduce the volume of output to conditions of smaller markets available or to alter the factor

proportions of labour and capital or to use locally available substitute raw materials. Adaptation and modification also involve re-design of a part or the whole of the plant and trials on scale models.

The phenomenal increases in population in this region and the rising pressure of unemployment dictate that efforts should be made to develop those industries and technologies which can maximise the use of labour and minimise the use of capital, always assuming that the chosen and appropriate technology will produce goods of a desired quality and price. The population of the region is around 1850 million and is increasing at an average annual rate of 2 per cent. The present economic plans with the hoped for infusion of foreign capital are unable to find enough jobs for the labour, which natural increases provide each year, let alone the large reservoir of unemployed already a burden to the economies of these countries. The indiscriminate intensification of the use of capital so as to maximise profit creates a dual economy and mocks poverty. There is now a growing conviction that employment should be treated as a primary, not a secondary, objective of development since it is the most powerful means of redistributing incomes. In the craze for higher GDP and high growth rates little attention has been paid to what is produced and how the benefits of growth has been distributed. It is assumed that the benefits will trickle down in time to the poor. In practice however the majority of the population of the country have remained

poor. Poverty which haunts the whole region has therefore to be attacked directly which means that national planning should concentrate not only on increasing production but also in determining what is produced and how the extra wealth from increased production will be distributed.

Such a new strategy of development will require a new set of priorities for research and development and in deciding on the options for industry, technologists need to be consulted. The poorer countries of this region have a limited capital and if development is to permeate to the mass of the poor, they must maximise the productivity of that capital. It is these factors that gave birth to appropriate technology as a development strategy. India's recognition of its importance is reflected in the establishment of a "Appropriate Technology Cell" in the Ministry of Industrial Development whose task is to identify suitable technologies in important sectors of the economy and to recommend measures that would help in the adoption of appropriate technology. The 'cell' has also been charged with the responsibility of selecting, adapting and developing technologies which are optimal in terms of capital investment needed for creating one work place.

It has now been proved that the possibility exists for introducing appropriate technology into Indian industry of all sizes. The priority needs were however in the smaller industries. Rural industrialisation in particular tends to benefit most from

this movement. Appropriate technology is a dynamic concept. A technology considered appropriate under a set of economic and resource patterns now will have to be improved in five years time if the factor proportions have then changed. This is common practice in the industrialised countries and the main cause of machine obsolence. Certain industries like oil refining, power generation or aircraft will be capital intensive - but a whole spectrum of industries can use labour intensive technologies, along side others in which different combinations of labour and capital intensity exist side by side. The identification of areas where such technologies could be employed and the development of such technologies through pilot plant and design studies is one of the responsibilities of an industrial research institute but is unfortunately not given the emphasis it deserves in the Asian countries outside India.

The main reason for the inertia in adaptation of technology, modification of machinery and development of appropriate technology is the lack of engineering design capability. Without this none of the work of development to near production stage is possible and without that visual demonstration the technology cannot be sold and consequently there can be no transfer. Design capability and well equipped machine shops to construct and test prototypes and stepwise scaled models should therefore be highly valued in any research institute serving industry. Most of the machinery and plant developed in the industrially advanced countries is designed for mass production.

Developing countries with comparatively small markets would need to design plant and adapt technology to suit both lower volume production and available skills.

When new technologies need to be developed to utilise a raw material peculiar to a country, the existence of engineering design services would permit the involvement of the engineer in the early stages of the development with considerable saving in time and money in the design of a pilot plant or model.

Product design is an integral part of production. It is essential to all manufactured consumer goods irrespective of scale. In handicrafts and small scale manufacture it is of special importance as good design simplifies fabrication, eliminates waste and increases saleability. Indigeneous manufacture must compete with imported goods right from the outset and design is just as important to the home market as for an export market. Product design is not only aesthetic beauty of line and shape but also improving functional utility and reducing cost by efficient use of material or method of manufacture. It is for this reason that a product designer works with engineers and plant designers. An American opinion on this subject states "Good design expands markets by providing new and better products. It adds value. It awakens the public. It changes the character of the market, moulds it and expands it. Without a designer we are stopped cold". Two developed countries

of this region Japan and Australia in their post war industrial expansion gave considerable attention to product design and design has always been regarded an essential element of industrial growth in these countries.

But in a large number of the developing countries of this region it is given meagre support except where a product has an export potential. Singapore established a Product and Design Centre as early as 1963. Hong Kong has a Design Centre established by the Federation of Hong Kong Industries which besides undertaking work for local industry also provides a 5 week course of training for designers in this region in Product Design and Packaging. Product design and plant design are inter-dependent and need to be a function of industrial search. It is hoped that this subject will receive increasing attention in industrial research institutes of this region.

It will be seen that the types of activity that should be accorded priority in an industrial research institute are those termed development and related to the area between small scale pilot plant trials on the one side and production trials on full scale plant on the other. It is also suggested that for the developing countries where entrepreneurs lack high technical skills the demonstration trials of a new technology should be around half scale. These types of activity alone will however not have the desired impact on industrialisation unless the work projects

of the institute are directed towards meeting established and planned needs of the country. Initial project proposals should be an inventory, resulting from an analysis and appraisal of the needs of technology and technical services necessary for enhancing the resources, and developing the existing and planned industries of a country. These will need to be evaluated in terms of established priorities, economic returns, utility, available knowledge from external and internal sources, available technical expertise and equipment, and cost of research and development before approval. R & D is an integral part of planning and joint consultation between planning and research in the formulation, screening and final selection of projects is essential if research for a country is to be meaningful. By the same token industrial R & D should be consulted by planning on the structure of industrial production, the availability of technology and its appropriateness, and in sector and regional studies. I like to feel that such a dialogue has begun in the region and will continue in the critical years ahead.

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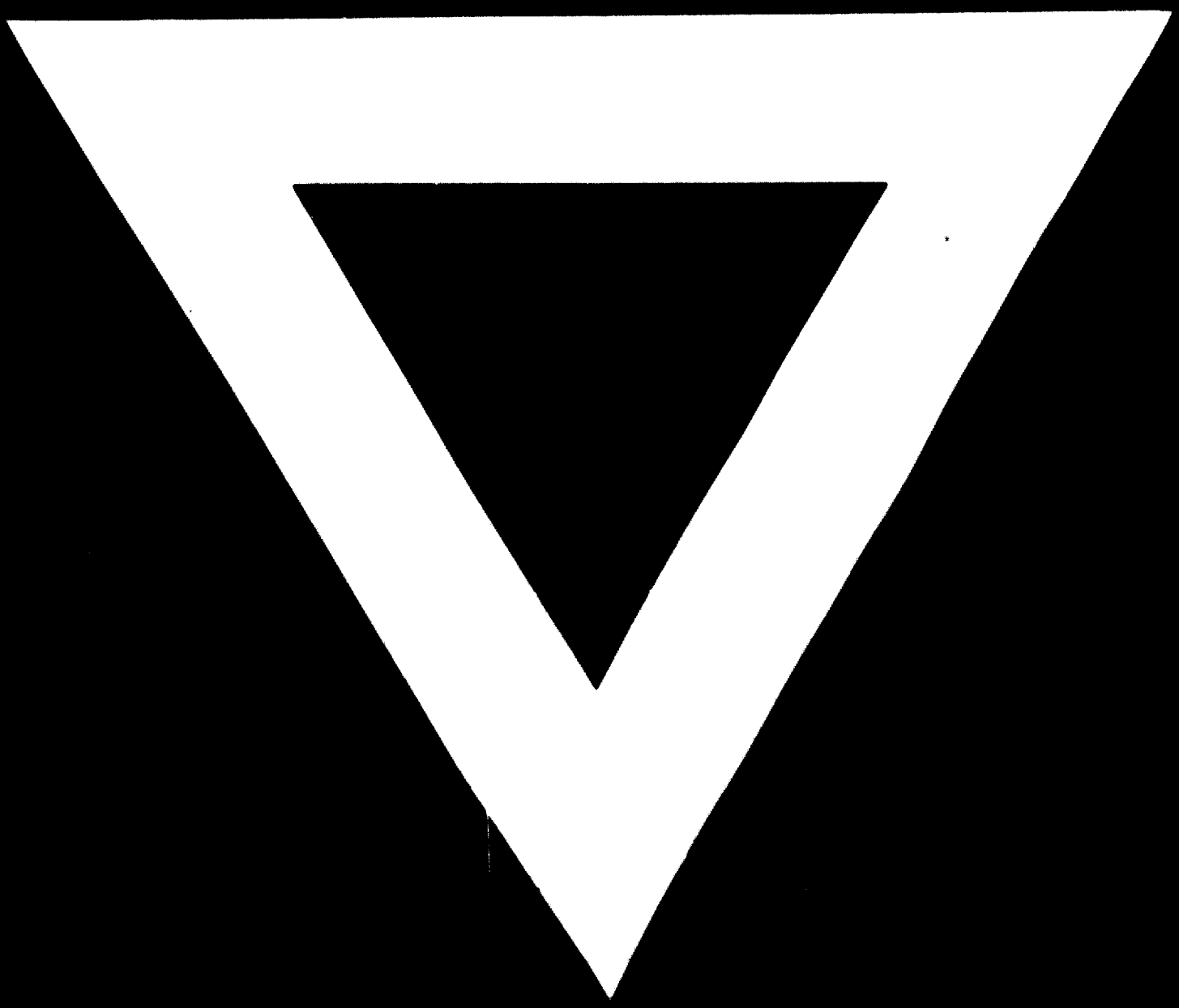

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