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DEVELOPMENT OF INFRASTRUCTURE FOR ENGINEERING INDUSTRY IN DEVELOPING COUNTRIES*

by

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C O N T E N T S

I. SUMMARY

Development of technology in developing countries has become a matter of urgency and of vital importance to the Third World, in their overall scheme of economic progress. In this connection it is realised that the main instrument through which developing countries could reach a stage of near self-reliance in technology is to develop the required infrastructure for technology and R & D. Without the creation of basic infrastructure for industrial development, one cannot also expect technology to develop. In order to minimise perennial dependence of developing countries for their technological needs from outside, it is imperative to first build the infrastructure base to absorb, adapt and innovate technology and progressively become self-reliant in this vital area.

Infrastructure for industry and development implies institutional framework and physical facilities required for establishment and operation of industries. Apart from providing the necessary frame-work of industrial planning and policy, the other major components of infrastructure include elements of physical infrastructure such as power, water, fuels, transport and communications and institutional infrastructure such as industrial finance, manpower development, consultancy and design services, research and development, industrial promotions etc.,

The development of physical infrastructure and institutional frame-work is an essential pre-requisite for establishment of industries. Firstly, an environment conducive to growth has to be created. The deep rooted rigidities and other obstacles faced by developing countries cannot be overcome by market forces alone. Hence planning becomes an essential feature of industrial development although the process and extensive planning and the role of the public and private sectors may vary from country to country. Appropriate government machinery has therefore to be set up to undertake planning to define the objectives of industrial development, determine priorities and regulate industrial development in accordance with plan objectives and priorities.

Another major factor required for promoting industrial growth is finance. No industry, big or small, can run without adequate finance. The industries require funds for meeting fixed capital expenditure as well as working capital needs. The fixed capital required by an industry is generally raised through the issue of shares and debentures to the general public and loans from financial institutions. The working capital requirements

are met from the commercial banks. Therefore, institutions such as stock exchange, commercial banks and financing institutions for providing industrial finance have to be created.

Industrialisation requires a steadily increasing supply of managerial and labour skills. The development of these skills frequently requires long years of training. The needs of the industrial sector have therefore to be anticipated much in advance. Expansion of educational facilities is an essential step in the generation of the manpower skills required for industrialisation. In developing countries where the social behaviour pattern, traditional forms of society are still strong, educational programmes have to more than create a technically qualified labour force. Education can help to create a disciplined way of thinking and acting. It can also help to broaden people's outlook and their attitude to work. As industrialisation advances, the education imparted in schools, colleges and universities has to be adapted to the changing needs of the economy. It is therefore an essential area of government policy to set up appropriate training institutes.

Another aspect of manpower training which is often underestimated is the need for developing entrepreneurial and management skills. Facilities have to be set up for developing top level and middle level managers. Along with increase in the supply of skilled labour, technicians, engineers and managers, adequate attention has also to be paid to develop entrepreneurship. Entrepreneurship depends upon the social and economic environment together with a psychological make-up for entrepreneurial activity to make it an attractive venture. Keeping this fact in view, one the one hand, an autonomy in decision making has to be given to the entrepreneur and on the other, a minimum provision of legal and legally enforceable institutional rules have to be framed according to which private economic decisions can be made and implemented. A legal framework hasalso to be established for protection of assets owned by an enterprise against appropriation by others as well as for protection of the contractual relationships. At the same time, legislation has to be enacted for protection of the workers as well as the community as a whole from exploitation by unscrupulous entrepreneurs.

To facilitate industrial development, a network of national standards is also necessary in order to create and strengthen the vital link between related industries and to establish close integration among them. Standardisation is also of considerable importance in international trade. It provides a reference in clear terms for the negotiation between buyer and seller, thereby facilitating the export of goods ranging from semi-processed agricultural products to sophisticated engineering products. Thus appropriate institutions for setting up national standards and ensuring quality control have to be established.

Given the policy framework, provision of finance and availability of skilled manpower, along with an appropriate environment for industrial growth, the pace of industrial development also depends to a large extent on the creation of physical infrastructure, such as availability of power, transportation, communication and basic raw materials like castings, forgings, steels and variety of ancillary parts and components. Unless physical infrastructure is created, it is not possible for the other industries to come into existence or to develop fast enough. As the development of physical infrastructure including the setting up of basic heavy industries involves heavy investment, combined with long gestation period,

and low returns, necessary investments in this field may have to be undertaken by the government itself.

This paper endeavours to present some of the essential components of infrastructure needed for the development of engineering industries including machine tool industry in developing countries.

II. INTRODUCTION

The crucial task of the developing countries is to overcome their technical, economic and cultural backwardness and raise the productivity of social labour to a level that would allow them to reach the target objective fixed three years ago at the Lima Conference of the developing countries viz., to achieve 25% of the world's industrial production in terms of added value by the year 2000 A.D. The scientific and technological revolution has created essentially new conditions for rapid economic growth in the backward countries which can now leap over some of the grounds traversed by the present day industrial countries. They can take stock of world experience both positive and negative, avoid the effect of environment of man's haphazard economic activities, adopt all that is best and make use of the advanced countries' technological innovations in the interest of their own progress.

Those are the opportunities; but the post-colonial record shows that the technical progress has made slow headway in the Third World. The widening gap between the industrial nations and the countries which in recent years have emerged from colonial rule have created

an awareness that a disaster might become inevitable if steps are not taken urgently to hasten the latter's progress. The developing nations have a share of only 7% in global industrial output though they are the home of more than half of the world's population! Eventhough there are pockets of prosperity in the developing countries, they are rolling down-hill in relation to the advanced nations.

The reason is not hard to seek. Most of the developing countries still lack the infrastructure necessary to realise the potentials of technological progress and become self-reliant technologically. The development of science and technology in these countries is faced with number of objective difficulties both domestic and external, resulting from the multi-structural economy, backward social relations and subordinate place in the world capitalistic economy. If the young national developing States are to advance along the road of technological progress, a whole range of inter-related measures has to be carried out.

III. SCIENCE AND TECHNOLOGY

The crucial and indeed vital role of Science and Technology in the development of economy needs no emphasis. Technology, representing as it does, the industrial application of science, is an embodiment of skills, knowledge and processes for production of goods and services through a systematic application of scientific laws and principles. Its development has to be planned and implemented to enable it to meet the socio-economic needs of society. These means obviously differ from country to country and even in the same country from time to time and any blue-print to fulfil them calls for a pragmatic amalgamation of basic science on the one hand and technology on the other. In both cases it is necessary to inclulcate in our minds a constant awareness of development in other countries as well as the will and ability to adapt and improve on them to meet the local conditions and the requirements. Japan is an outstanding example of innovative adaptability practised with imagination and efficiency. They have over the last 35 years or so, built up their magnificent industrial edifice on the foundation of concepts and practices of technology, painfully and patiently worked out by other countries.

By deliberate and intelligent exploitation and utilisation of work done in other countries, they have so organised their programmes and development of technology, supported by a sense of discipline and remarkable devotion to objectives as to now rank as one of the super powers in the industrial field.

IV. VITAL ROLE OF ENGINEERING INDUSTRY

For the multi-dimensional development, an accelerated industrialisation forms an essential element in the developmental strategy of any developing country. The logistics of this strategy demand development of high technological capability. The basic tool deployed for the realisation of this goal is the creation and promotion of 'engineering sector'. The engineering industry thus represents a core of the process of industrialisation as a whole.

Engineering industry including machine tool industry provides the base for industrialisation. A broad based industrial structure cannot be sustained except on the basis of a strong vibrant growth-oriented engineering sector. The engineering industry is also the source for the growing pool of expertise and development of technical manpower.

A primary propellent to the engineering industry is the deliberately designed policy to reduce the country's dependence on imported technology. A substantial expansion of the industrial structure vihout the technological base is, to perennially depend upon imported technology. The growth of indigenous engineering skills and technological know-how is considered

foundational to economic independence of the entire developing world.

Furthermore, it is recognised that high engineering skills and expertise alone could lead to high productivity levels and as a result to high levels of income. It is thus not merely for its isolated development that the engineering industry is to be promoted but it is also to act as a catalytic agent for the entire economic development of a country. Therefore the establishment of an engineering industry constitutes an essential item in the technological infrastructure for any developing country. It establishes the very essential skilled base for technical progress. It is labour intensive unlike many of the heavy and process industries. It permits the indigenous development of appropriate technologies and their innovative developments for manufacture of innumerable engineering items including capital goods like metalworking machine tools, intermediate products and consumer durables on small, medium and large scale. The natural byproducts are also the ancillary industries.

Among the multitudes of engineering products, machine tools play an important role in the overall process of industrialisation. It takes machine tools

to build industry and machine tool industry is basic to any country's industrialisation. In fact, every human artifact is made on machines which are made on machine tools. Machine tool industry is the main plank on which a nation's industrialisation depends. Hence it is advisable for a develo ing country to assign high priority to machine tool industry in its overall plan of development of engineering industry.

V. PHYSICAL INFRASTRUCTURE

There cannot be uniformity in the degree of industrial development among all the developing countries. Some countries like Mexico, Venezuala, Argentina, Brazil, Singapore, India, South Korea and Taiwan have adequate infrastructure to adapt, absorb, innovate and in fact develop some of the engineering and capital goods much more easily and rapidly than say countries in Africa, the Middle East, Burma, Indonesia and other Asian countries. Hence methods of initiating production of engineering goods could vary widely from country to country depending upon the level of industrial development of a country.

Most of the developing countries have instituted their own economic plans of development on long term basis. In formulating a country's economic plan, the planning of industry including engineering industry should find a priority place indicating the demands at macro-level for various engineering items and capital equipment which would give the local entrepreneurs an opportunity to select and venture to take up for manufacture of a particular item of engineering goods in the country. In developing countries which have very low industrial

base - some none at all- and which depend on imports of simple items like nuts, bolts and handtools, there appears to be no need for carrying out any detailed market survey for producing some of the elementary types of basic engineering goods including machine tools. A beginning has to be made by creating physical infrastructure and centres of training of skilled manpower and managerial personnel, foundry and forge facilities supported by import of ancillary items and accessories. As demand builds up, more and more engineering items could be introduced which warrant in turn the creation of supporting industries and other material and manpower inputs.

Physical infrastructure is an essential prerequisite for the process of industrial development including the development of engineering industry. The planning and provision of physical infrastructural facilities like electric power, transport and communciation systems including railways, roads and shipping, must be undertaken to make sure that such facilities would effectively meet the projected needs of industries. Sometime doubts are raised that unless basic physical infrastructure is built, it is not advisable to embark upon establishing any industry including engineering and capital goods

industry. This is not always true in the case of many developing countries which have yet to embark upon even a modest plan of industrialisation. If examples of some of the developing countries having relatively well established industrial base is any guide, one has to simultaneously develop both these, viz., creation of physical infrastructure facilities and broad based industrial sector giving preference to basic industries like engineering industry including machine tool industry. As otherwise, valuable time would be lost in trying to build physical infrastructure and await the latter to reach satisfactory stage of development before starting engineering and other basic industries. In fact, tackling both these needs simultaneously may generate internally self-imposed demand push - one chasing the other - with the result both these requirements are fulfilled without much waste of time. What is however more important is the fact that a country's development plan must indicate broadly how these needs are planned and to be met within a given time period.

Irrespective of the level of industrial development of developing countries for production of engineering goods, all of them have to give priority

for setting up facilities, for among others, the following essential items : (a) ferrous and non-ferrous castings; (b) forgings; (c) machine tools and machine shop equipment; (d) fabrication (including weldments & stampings), rolling and bending and pressing facilities; (e) heat treatment and plating; and (f) steel rolling mills.

Raw Materials: Dealing with the raw materials needed by the engineering industry, among the many, basic ones are steels, castings, and forgings. Steels: Construction steel (mild steel), alloy steel, sheet steel etc., are the most essential raw materials required in the production of engineering items. Though compared to castings both ferrous and non-ferrous, generally the proportion of steel is less; still, the latter forms a very vital component raw material for the engineering industry. As to whether every developing country should develop its own iron and steel industry depends upon various factors. Undoubtedly, it is advantageous to develop one's own iron and steel industry if the necessary mineral resources are abundantly available. For example, India with its rich deposits of iron and coal, has been wise in expanding and developing its own iron and steel industry since independence. When the country became independent

during 1947, considerable debate took place among the world economists and industrialists as to whether India was wise to expend its enormous resources to build its basic industries like iron and steel instead of enriching its agriculture. Subsequent three decades have proved that the Government of India has been on the right path in establishing several basic industries including the iron and steel industry, primarily in the public sector. In spite of the total production of steel of the order of about 9 million tonnes during the last year, India had to import and is importing this year substantial quantity of steel to feed its giant engineering complex. The case of Iran is somewhat different. In view of the country's large oil resources, Iran has set up large steel mills importing almost all the raw materials from abroad like iron ore from India. Hence the question as to whether a developing country should venture into iron and steel industry is dependent on various considerations like the availability of power, coal, iron ore, market requirements etc., Hence a careful economic feasibility study of various factors becomes necessary and above all, the political and economic will of the country plays its own role in such basic policy decisions.

However, many developing countries who have not reached high level of industrial development and who are not endowed with essential raw materials like iron ore, coal and abundant power, would be well advised to import whatever little steels that would be initially needed for their nascent engineering industry.

Castings: Among the primary raw materials that are needed for the engineering industries, fall the ferrous and non-ferrous castings. Even here, cast iron components generally contribute a large share of raw materials needed in producing many of the engineering items. Cast iron and non-ferrous foundries and forge shop are the main sources for providing the raw materials needed by the engineering industry. Hence their establishment should be given high priority.

As mentioned before, raw materials like steels including varieties of alloy steels present much less difficulties in procurement as these could easily be obtained in standard sizes and of different varieties of alloy steels, from outside if not available indigenously. This is what had been done by some of the developing countries who today possess a substantially large engineering

industry of their own. However, cast and forged components are to be made specifically to drawings of components. Hence these are more advantageously produced in the country itself.

In the beginning when the development of engineering industry is on low scale, it is best that each of the engineering unit produces its own cast components and sets up its captive foundries. But when engineering industry develops into substantially large one in number and size, it may be advisable from the point of view of economy to take advantage of scale of operation and specialisation, to set up large scale jobbing foundries and forge shops. Such an effort will give further impetus to specialisation in foundry and forge technology.

Bought-out components: These are standard engineering items as distinct from specially manufactured components of an engineering product. In this category fall items like ball bearings, clutches, switch gear, electric motors and similar items which can be common to many engineering and capital machinery. In the beginning, when a developing country's need for these standard (apart from say Electric motors) items,

or some of these items is low, it is best to import them from abroad. When demand picks up with the growth of engineering industry, for some or many of these items, thus rendering their production an economical viability, it is best to establish such supporting engineering industry to be quickly self-sufficient to meet the domestic markets. The growth of manufacture of such standard engineering items depends largely on the growth of the engineering industry as a whole and its market potentiality.

VI. INSTITUTIONAL INFRASTRUCTURE

Skilled manpower and managerial and technical manpower: Though in most of the developing countries skilled manpower, experienced technicians, administrators and managerial personnel needed for engineering industry are not easily available, there is however abundant manpower capable of being trained for these cadres. It ismainly the creation of opportunities for them. In the past, and many developing countries even at present, generally provide education and training facilities for the manpower mostly for gernment services and in fields other than industry, like education, agriculture, health, medicine, transport, communication etc., But with the plan of industrialisation, it is time that the developing countries devote their attention to the requirements of industry as well.

Developing countries have to take policy decision to train their manpower in engineering trades on systematic lines and provide sufficient resources. They could also seek international assistance for the purpose. One should not repeat mistakes which other developing countries have perhaps made in this direction. Unplanned methods of developing skilled manpower actually costs countries more than if governments tackle the problem correctly from the very beginning.

Vocational training centres for training engineering tradesmen like fitters, machinists, welders, electricians, carpenters, pattern makers, moulders etc., should be established. Normally entrance to these training institutes should be for candidates who should have completed the school final studies. Industrial training centres should teach basic shop mathematics & mechanics, workshop calculations, machine drawings, elementary metallurgy, tool geometry and the like and provide intensive practical training in various engineering trades and to some selected candidates, advanced training to qualify in highly specialised skilled trades.

In this task it may be necessary to perhaps obtain assistance from industrially advanced developing and developed countries for deputation of instructors and for procurement of training centre equipments, tools, instruments and other training aids. After the boys have successfully completed various courses of vocational training they should be sent out to the industry for 'on-the-job' training and eventually absorbed as skilled workmen in the enterprise. This is one important area where the better placed industrially advanced countries and international organisations

like the UNDP, ILO and UNIDO can offer to set up training centres and apprentice schools where the equipment and training aids are made available by the donor countries/organisations together with competent instructors and demonstrators. There are many benevolent and charitable organisations of international status who also extend assistance for setting up and running training centres and apprentice schools in developing countries. Full advantage of such programmes must be taken as well.

Sometimes it is a case that a country in its enthusiasm, turns out large number of vocationally trained personnel, overlooking the fact that it is also the responsibility to provide them with jobs in industry as they come out successfully from various training and vocational centres and apprentice schools. For instance, in India at one time particularly during the economic recessionary period in late '60s, the country had surplus of these trade apprentices as industry could not absorb them. The whole programme of training skilled manpower must be so co-ordinated that as far as possible, needs of industry should be matched with the supply of trained personnel from the

trades and vocational apprentice centres. It is sometimes better, however to have more men trained than necessary, since many of them could possibly turn to other entrepreneurial avenues such as setting up of their own small scale engineering and ancillary units. Some even may migrate or go on short-term employment to countries where skilled manpower is needed to run industrial and technical operations. Surplus skilled manpower in any country does not go waste and in fact it has a snow-ball effect of pushing the country's pace of industrialisation as it has perhaps happened in the case of India.

Technical and supervisory personnel: The programme of polytechnic institutes in developing country could constitute the basis for providing manpower for training of supervisory personnel, middle level managers and technicians needed by the engineering industry. Technical competence needed in the engineering industry is of high level and of diverse discipline. Designing of industrial products, tools, fixtures and other production aids, preplanning, methods engineering, production technology, quality control, material management, inventory

control, value engineering etc., are some of the essential facets of engineering needed in the industry. To provide training facilities for persons to handle these specialised tasks is another important consideration for the developing countries who should provide for such training programmes in their technology plan. The important consideration is that such institutes must have close links with industry and plan to meet the needs of the engineering industry not only quantitywise but with quality considerations.

Engineering & Management Personnel: An important infrastructural base for the adaptation and absorption of technology is the availability of trained engineers, designers, high level technicians, managerial and business administration personnel. It takes long time and considerable resources to develop these cadres for industry and business. Hence careful and advance planning is called for. Adequate resources should also be provided to develop such specialised expertise in the overall technology plan of the country. Some of the developing countries though have no strong industrial base, like Ghana, have sufficient reservoir of technically and scientifically qualified personnel to meet the immediate needs as far as manpower for this purpose is concerned. The

high standard of technical and scientific education imparted at the universities and technical colleges has generated in Ghana, intelligent and resourceful scientists and engineers in the country. The University of Science and Technology at Kumasi with its Technology Consultancy Centre, the Centre for Development Studies in Cape Coast and similar institutions are in operation in Ghana. Similar institutions elsewhere in developing countries could normally provide the manpower for training of managers, higher technical personnel, designers and research staff needed in the engineering industry in particular and generally in industry and business as a whole.

With suitable training and practical experience in more industrially advanced countries, the personnel could become capable of acquiring the required knowledge in technology. In so far as in-service and inplant training is concerned, it may become necessary and advantageous for developing countries to get experts from abroad preferably from collaborating firms engaged in transferring a particular engineering product or process technology and to place local personnel as counterparts to foreign experts on deputation so that eventually, the local personnel could take over from the foreign experts. It may also become necessary to send some of the key personnel for training abroad at the collabo-

rators firms to learn on the job intricacies involved in the engineering technology.

Management Education and Business Administration: Increasing realisation and appreciation of the role of human capital in modern development process has led to the establishment of business schools all over the world. Their sole effort is directed at developing skill, leadership and entrepreneurship of those involved in decision making process of the industry and business organisations. Management education should therefore receive increasing attention, with a view to meeting the ever growing demand for trained manpower in developing countries. In these regions, where the concept of modern industry is in an evolutionary stage, the demand for trained manpower will be of varied nature specially when one considers the problem in the context of vast natural resources of these countries, which in turn provide many more challenging opportunities to young entrepreneurs for accelerating the process of industrialisation in their respective countries.

There is however a serious lacuna in the developing countries in the field of advanced training in business management. This need would become more important and urgent as the

developing countries get progressively industrialised. In the beginning when modern facilities do not exist for training in this field, it may be advantageous for some of the key management and government personnel concerned with selection, negotiation and assimilation of engineering technology to be sent abroad to reputable management institutions. This could enhance their knowledge in business administration and management.

Finance: The industrial finance as one of the main components of the institutional infrastructure, is the backbone of the industrial development without which no developing country would successfully build its engineering industrial sector. The governments of developing countries must therefore plan and establish a number of special financial institutions to assist financially the entrepreneurs both in private and public sectors to set up engineering units in the country.

In this regard, it may be worthwhile to quote the experience of India in providing long

term finances on soft terms to entrepreneurs to generate industrial activities by starting of thousands of engineering factories in small, medium and large sectors.

As a first start in this direction, the Industrial Finance Corporation of India was set up in 1948. Since then a number of National and State-level term lending institutions have been established. Some of the major financial institutions are : the Industrial Development Bank of India (IDBI), the Industrial Finance Corporation of India (ICICI), the Industrial Reconstruction Corporation of India (IRCI) and the State Financial Corporations in almost all the States, the National Small Industries Corporation (NSIC) and the Export Credit and Gurantee Corporation Ltd., (ECGC). Apart from these, certain others like the Unit Trust of India, the Life Insurance Corporation, General Insurance Corporation, Nationalised Banks, State Industrial Development Corporations and the State Small Industries Corporations also assist in providing loans for establishment of industrial units, expansion and rehabilitation of existing ones.

The IDBI is the apex financial institution which acts and co-ordinates in conformity with

national priorities the working of the institutions engaged in financing, developing or promoting industry. The main functions of the Bank include : (i) direct assistance to industrial concerns in the form of loans, underwriting of and subscriptions to shares and debentures and guarantees; (ii) refinancing of industrial loans granted by the banks and other financial institutions; (iii) rediscounting of bills arising out of sales of indigenous machinery on deferred payment basis; (iv) financing for exports in the form of direct loans and guarantees to exporters and buyers abroad in participation with commercial banks and refinancing of medium term export credits granted by commercial banks; (v) assisting other financial institutions by way of subscription to the shares and bonds; (vi) undertaking industrial potential surveys in industrial areas which are less developed (the purpose of these surveys being to identify specific project ideas in the light of the resources, endowments, demand conditions and infrastructure facilities over a period of time); and, (vii) to set up state-level technical consultancy organisations with a view to promote diffused growth of industries by identifying

projects, preparing feasibility studies, detailed project reports etc.,

The IDBI also operates Buyer Credit Scheme. Under this Scheme, it grants credits to foreign buyers in participation with commercial banks in India for export of capital goods for financing self-supporting projects. While no maximum limit for such credits is stipulated, applications in respect of high value contracts exceeding Rs.10 million are normally considered by the IDBI.

There are other institutions (some named above) which have been set up for providing specialised assistance to specific types of industries. For example, IRCI provides financial assistance for rehabilitation of industrial units which have turned sick; the NSIC arranges for the supply of imported as well as indigenous machinery on hire purchase basis to small scale units and the ECGC provides finance for India's export trade.

Foreign exchange is a chronic shortage in most of the developing countries and without it, it is hardly possible for them to start any engineering and manufacturing industries. Capital outlay in imported plant and machinery, designs, technology, training etc., become substantially high in respect of machine building;and with relatively long gestation

period resource allocation could constitute a significant constraint. This has perforce required the governments of developing countries to set up enterprises in public sector for machine building and machine tool manufacture.

Private sector investments in this sector in developing countries has largely taken the form of partnership with foreign manufacturers in the form of joint ventures. However, such an approach has its own limitations in that the interests of the foreign partner or the licensor do not necessarily coincide with those of national enterprises.

Apart from direct financial investment requirements, it is imperative that financial facilities are also available for import of machinery and equipment needed by engineering and machine tool building industry in the developing countries. In this connection, foreign exchange loans under soft terms are provided by the international financing bodies like the IDBR, IFC & IDA in respect of deserving proposals/projects. However, major incentive for plant and machinery import is the suppliers' credit, government to government credit and project aids from developed countries.

VII. TECHNOLOGY FOR ENGINEERING INDUSTRY

Most of the developing countries lack infrastructure of technology base to develop their engineering and machine building industries. Although many of them have established higher secondary and university level educational facilities for teaching in science and engineering, they lack in adequate number of technological institutes which could provide basics of modern engineering and production technology, planning and management. This is perhaps because of the low level of manufacturing and industrial activities in these countries.

There appears to be two main cources open to developing countries to build their technological base. One is to import ready-made designs and technology from other countries and the second, to make use of scientific ideas and discoveries to develop technologies and designs of their own for building engineering goods. Of course, these are two extremes of a whole range of possible solutions. Any cut and dried answer to the question of how to develop technological base would not be possible since it would ignore the reality of the diversity in the economic and

industrial development of the countries in the Third World. What is probably right at one stage of development may prove wrong at other higher stage. It is important therefore to formulate general principal approach to the solution of this problem. But one thing appears to be definitely essential, i.e., technology cannot be mastered, adapted to local conditions, improved or renewed without a scientific infrastructure and a build-up of local R&D potential.

The international technology market for designs and know-how for production of engineering goods and machines present a fairly wide area of technological possibilities and choices, except perhaps in respect of highly sophisticated machinery products. It is imperative that the choice of technology as also that of the licensor is exercised with great care and deliberation particularly if foreign capital ownership is involved.

The terms and conditions of technology licences merit special consideration as the nature of licencing arrangements whether accompanied by foreign investment or not need to be more comprehensive and of a more continual nature. The coverage of the licence agreement as also the technological

services to be provided by the licensor need to be spelt out in great detail. Such services should include (1) part-lists drawings of individual components, material specifications & heat treatment details; (2) Operation layout, process sequence, selection of types of machines and standard toolings, design and manufacturing details of jigs, fixtures, special cutting tools, gauges etc., and machine set-up procedures; (3) Quality control procedures and test standards; (4) Purchase procedures including inventory control; (4) Pattern drawings for castings, forgings etc., indenting procedures and the like; (6) Sales and after-sales services. It is essential that access to improvement in designs and production procedure is ensured throughout the period of contract including access to new patents that may have been applied for or registered by the licensor. A vital aspect is that of training of personnel of licensee enterprises not only in production methods but at various levels and also in the preparation and adaptation of drawings and design improvement capabilities and the like.

It is necessary that transfer of selected technology is not only full and complete but on suitable terms and conditions. Tie-in provisions

must be incorporated in the licence agreements for supply of components and parts needed in the initial stages to commence production as early as possible and put the machines in the market to assess the marketability, quality aspects and the customers acceptance etc., However, this aspect must be viewed in conjunction with appropriate domestic integration programmes in each case and the cost of imported components must be consistent with competitive pricing of the final product. Restrictions on exports must be avoided and efforts in fact should be made for external markets to be shared by the licensor and licensee enterprises in developing countries. Technology acquired in this sector must be so secured that licencee enterprises are able to absorb and adapt such techniques adequately and expeditiously so that licencees can stand economically and technologically on their feet within the period of agreement.

Negotiations relating to technology acquisition in case of engineering products and machines follow a somewhat different pattern than that of process technology such as petrochemicals and fertilisers. The role of developing countries' governments and their regulatory

agencies would be also critical, apart from that of licensor and licensee directly involved in the technology transaction. Governmental and institutional agencies in developed countries could also play a significant part in ensuring effective transference of technology in this sector.

VIII. MARKETS

Undoubtedly one of the primary considerations in establishing production facilities for engineering items and machinery, is that there should be adequate domestic demand for these items, currently or in the near future. Although macro level studies in this regard will be of a guidance, a detailed itemwise market study appears to be necessary which should be based on present consumption through imports and future projections. However, for developing countries who have a low level of industrial activities and who are just about to commence their engineering industries, it is not important to prognasticate in any elaborate manner the existing market requirements. Instead, an intelligent forecast of the near future market is all that may be needed. Of course investment plans of the country over a period as assessed by governments in their respective economic plans, import statistics and import estimates may throw some light in this regard; but, with a low level of demand, it appears necessary to make efforts to <u>create</u> demand for essential and basic engineering items and as demand progressively picks up, increase the production.

Exports: It is necessary to visualise production of engineering items from the very beginning in terms of global market and appropriate arrangements needed, are to be made for extending the sales to external markets. While competitiveness in terms of price, quality and delivery will need to be ensured by manufacturing enterprises in developing countries, an appropriate international relationship needs to be evolved to enable such machinery and engineering products to effectively enter the markets of developed countries.

In order to enable the entrepreneurs to enter into the highly competitive markets of the developed countries, a package of incentives and facilities should be provided by governments of the developing countries which are at least comparable to facilities provided by governments of industrialised economies, such as deferred payments, export credit guarantees and the like. In addition, the developing countries should provide import entitlements, tax rebate, custom duty drawback and cash incentives to exporters. All these need to be studied with a long range view and a comprehensive package of facilities and incentives need to be drawn up together with development of technological services

particularly consultancy engineering and design capability in developing countries, so that these countries can gradually achieve parity in technological capability for the future growth of the engineering sector.

It is essential that an effective complementary role is discharged by developed countries and that schemes such as that of "tied-aid" are replaced by financial facilities which can be availed of in any country on purely competitive terms and necessary flow of resources and technology on acceptable terms is ensured. An appropriate international pattern of cooperation must be developed in order that engineering and machine building industry in developing countries can flourish and participate effectively in international markets.

IX. ROLE OF COUNTRY'S GOVERNMENT AND INTERNATIONAL AGENCIES

Government's role: An issue which clearly emerges from the above study is that for the planned growth of engineering and machine building industry in developing countries, an active and participative role on the part of the governments of developing countries, both in planning and in implementation of investments in production programmes is very necessary. In fact concerned government authorities in developing countries must take initiative in both planning and implementation of production programmes of engineering and machine building industry. In most developing countries, governments do play a fairly active role in planning and co-ordinating of industrial growth generally. However, in regard to engineering industry, this is more basic necessity. Besides, institutional agencies for planning and financing must be closely associated both with initial projections and in identifying of engineering products to be manufactured and fix priorities. Government agencies should associate and oversee aspects like resource mobilisation, selection of technology, determination of levels

and phased integration programme, pricing of final products in relation to comparable imported products and so on. They must actively support the development of supporting and input industries and evolve national engineering standards including testing and acceptance standards for each and every engineering item produced in the country.

Governments of developing countries must be concerned with policy matters like sources and prices of machinery imports, degree of protection through import controls and/or tariffs, the period of such protection and incentives for import of engineering goods. Governments must provide adequate technical education and manpower training facilities and the like.

Role of International Agencies: International agencies like the UNIDO should play leading role in assisting the developing countries to establish this critical sector of industry viz., engineering and machine building industry. Busides, the agency should bring about and assist the growth of international relationships among developing countries themselves to help each other to their mutual advantage, besides generate close links with the developed countries wherever necessary. The UNIDO should be

able to perform a vital role not only in programming the development of engineering industry in developing countries and regions but also in assisting in the acquisition of technology for manufacture and in the promotion of specific engineering projects in this vital industrial sector.

X. CONCLUDING REMARKS

Pressing need for the developing countries is the development of technological capabilities not only to absorb and adapt imported technologies but to become more and more self-reliant in evolving their own technology base and innovate, articulate pure science in a manner that it develops into technology to suit respective countries' social and economic conditions, utilising the available resources to the maximum. In this exercise, they must not ignore the mistakes committed by the developed countries whose technological development on which their economic prosperity was based, took place in an era of "cheap oil". With price of petrolium having increased over six times since the early 70s, many of the modern technologies dependent on oil and petrolium have become economically questionable. Furthermore, ecological and pollution problems which have shaken the very foundation of modern technology so far exploited by the developed countries, could constrain the use of such of these advanced technologies invented by the highly industrialised countries.

In any case, for most of the developing countries, at the present stage of development

with abundant manpower resources and the prevalence of small scale production, labour-intensive methods can do much to mobilise untapped labour resources, raise the effectiveness of production and alleviate the imbalances arising from the breakdown of the colonial type economic structure.

That is precisely why the renewal of the developing countries' industrial and technical base is not a mere transfer of technology and equipment. This renewal should combine three main types of technological innovations: technologies already being used in the industrialised countries; original technologies specially adapted to the conditions of the developing countries; and, lastly the technologies of the future, based on the latest promising scientific discoveries and essentially new technologies. These are urgent and vital for the developing countries to become as soon as possible self-reliant in development of technologies.

One must also bear in mind that the 'technology transfer' is no act of charity. It is not done gratuitously, but on commercial basis, which puts heavy financial burden on the developing countries. It has been estimated that

in late 1960s they were paying something like $ 1500 million a year for patents, licences, know-how, trade mark, expertise and consultant services alone and by the end of the present decade, this figure is expected to reach $ 9000 million a year, that is, 15 per cent of their expected total export foreign exchange earnings. To this, one must add the high import costs of equipment, plant and machinery, overpricing of raw materials and semi-manufacturers, payments to foreign firms for transfer of production secrets, technological know-how (notably through acquisition by foreign investors of equity participation in newly created companies) and profit repatriation of the wholly owned subsidiaries and joint ventures. According to one estimate, the total foreign exchange payments by developing countries for the transfer of technology under all these headings will be in 1980 at least twice as high as the above figure i.e., around $ 18,000 to $ 20,000 million per year.

Time is running fast and not in vaour of the developing countries, unless they make determined and concerted efforts to become self-reliant and develop their industrial technologies and for this purpose build the foundation by way of needed infra-structure.

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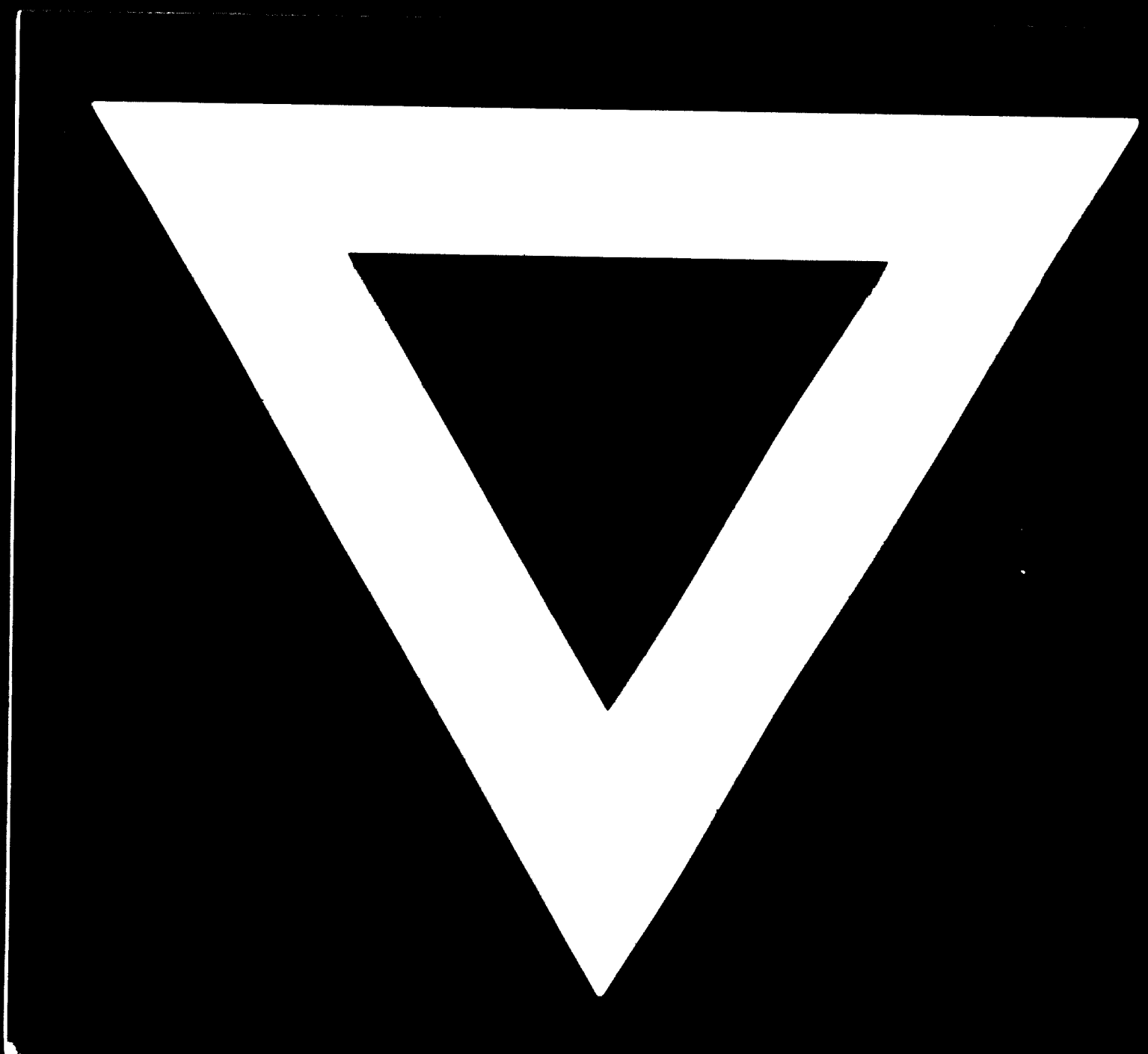

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