

SOME THOUGHTS CONCERNING A STRATEGY FOR THE INDUSTRIAL TRANSFORMATION OF A DEVELOPING COUNTRY

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The process of industrial transformation in technologically less-developed countries can be conceived as being part of a larger and much more complex process of nation-building. This could be understood to be the course through which a people in a particular state develop their common identity and philosophy of life, evolve their own characteristic way of living and working together and realize their economic, cultural and political potential as a distinct national entity. Nationhood in this sense involves much more than the possession of the formal requirements of political independence. It is characterized by a people's capability to stand on their cultural identity and their power to maintain their political integrity. Economically, it involves the ability to produce the goods and services it needs for its own consumption and those demanded on the world market to trade for the goods and services the country needs but cannot produce. For all this, the capability to acquire and develop technology is crucial. For without it, the possession of even vast reserves of natural resources will not be a controllable asset while with science and technology, the lack of natural resources will not be an insurmountable obstacle.

There are certain principles which ought to be practised in the application of science and technology for nation-building. Being a mixture of factual as well as value statements, they may be regarded as representing my basic philosophy on this issue. Briefly, these principles are:

Basic Principles

First, education and training in the various sciences and technologies relevant to the nation-building needs of the country must be undertaken. This involves both in-country as well as education and training abroad.

This is an essential step. It is however, by itself, not sufficient.

In addition, a clear, realistic and consistently applied concept of the nature of the society to be developed and the technologies needed for the realization of this future society must also be evolved. These technologies need not necessarily be the most primitive. They may indeed in many cases be the most advanced in the world. The only criterion for the appropriateness of technologies for any particular country including technologically less-developed countries, is their utility in solving actual problems in that particular country.

Third and perhaps most importantly, technologies can only be transferred, adapted and further developed through their being applied to concrete problems. By their very

nature, technologies cannot be learned, let alone be developed, in the abstract. To develop rice production technology it is of course very important to study rice agriculture and the various rice production technologies available in the world today. Yet most importantly, one must actually try to produce more rice under given soil, climatic, economic, social and cultural conditions. Only through working on concrete production problems is the actual working of particular technologies comprehended. And only when thus comprehended is their further development possible.

Fourth, and as a corollary to the previous principle, for a country to develop itself technologically, it is vital that it solves its own problems by itself. To develop its technology, no country can continue to be a net technological importer indefinitely. At some point it must be able to develop its own technologies.

Fifth, in the very first stages of transforming itself into a technologically advanced nation, every country must protect the growth of its national technological capabilities until its international competitiveness has been established. I quickly add that one must plan to achieve such international competitiveness as soon as possible.

These, then, are some of the principles that must be observed in the execution of a strategy of the application of science and technology for the technological and industrial transformation of a developing country.

Many strategies are possible. Conceptually, there are two elements of this strategy. The first element are the phases of the strategy; the second, the vehicles of its implementation.

Phases of Transformation

The process of the transformation of a society into a technologically and industrially developed nation may be conceived as consisting of four overlapping phases. Three of these are of relevance to the presently less-developed countries while the fourth is vital to the preservation of technological prominence.

The first most basic phase is the use of already existing technologies for added-value processes in the assembly and manufacture of products already on the market. This includes both the domestic as well as the international market. In this phase, manufacturing and management technologies are used to transform raw materials and intermediate goods into higher-value finished products. In doing this, one could of course utilize the technologies already existing in the country. This, however, would not automatically lead to technological advance. To improve existing technologies one could make investments in additional research and development. In many cases, however, this would lead to costly and time-consuming "reinventions of the wheel" in many areas. The logical shortcut to take would therefore be to import technologies from abroad and produce under licence. Progressive manufacturing programmes will be needed to help ensure the systematic transfer of licensed technologies by relating the progression of transfer to the number of items produced rather than by setting time-targets. Through this step, capability is obtained in the understanding of more advanced designs and manufacturing processes developed abroad. Better manufacturing skills as well as organization and management capabilities are developed. Work discipline is inculcated. Quality standards are enforced. The maintenance of work and quality standards become habitual.

The second phase is the integration of also already existing technologies in the design and manufacture of completely new products. In this second phase, technologies are

used and developed to create blueprints and designs thus adding the element of creativity to the first phase. In addition to design capability, other skills are gained. These are skills in integration and optimization of components into new systems and based on these, the ability to select, from all the possible designs for components of the new system, those that will be the most optimal. Essentially, any product can be seen as a system consisting of various components each of which requires a particular technology to manufacture. In this system, each component derives its value on the market from its function within the total product in the same way that the total product derives its market value from its function in the market. No matter how well designed, no under-carriage system, no propeller will have any value on the market unless it can be integrated into an existing or future railway wagon or airplane. Tires, engines, avionics and other components will enter the market only through their being integrated into an airplane. Components will enter markets only through fulfilling their function in products which, in turn, fulfill their own particular missions in society. The development of design and integration skills, therefore, quite naturally brings with it the opportunity to select, from all the available technologies existing in the world, including the most advanced, those most suitable for the new product to be designed and manufactured. And these opportunities will be generated automatically by the market without cost to firms in this phase of development because manufacturers of components will strive to offer their designs and products to firms in the process of designing new manufactures.

Quite suddenly, driven by the force of the market, the flow of technological information to the country increases, including information on the latest developments.

Since the new products has to be tested on the market and in the laboratory, testing capability is therefore also being developed at this stage as are marketing and new management skills. The role of research and development is much more pronounced in this phase rather than in the previous phase requiring the improvement of among others, facilities for design, for testing, and for simulation.

The third phase is the stage of the development of technology. Existing technologies are improved and new ones developed in the effort to design and manufacture the products of the future. If in the second phase one can avail oneself of existing technologies, there is a need at this stage for the creation of completely new ones.

This is, of course, the scenario familiar to scientists and technologists in technologically developed countries and which is becoming established in the so-called "newly industrializing countries" today. Firms and countries neglecting to make investments in new technologies will in a very short time lose their competitive edge. The third phase, therefore, will be the phase of innovations, of the creation of the technologies for components to be integrated into products which in their time, will be the most advanced in their respective markets. This phase is a necessary stage for every firm and every country wishing to maintain their position in the market. And however far this stage may seem to many less-developed countries today, it would be wise for these countries to plan on, eventually embarking on this stage of their technological and industrial development lest they lose the advances they will be making in the first and second stages.

Firms and countries in the third phase of development will very often find that in many cases there exist gaps in theory which need investment in basic research. This may be called the fourth stage in the development of science and technology for technological and industrial transformation. New developments in information technology

in control, and in computer technology are already at this moment ushering new ways of life and work in industrially developed nations.

While some developing countries do make investments in basic research, many find that their scarce financial, material and human resources are better spent in more urgent tasks. The great bulk of basic research is therefore undertaken in developed countries with developing countries maintaining access to this research and its results through cooperative agreements in science and technology. While not completely irrelevant to less-developed countries, this fourth phase of development is not as central to their transformation as are the first three phases.

In all of these phases the principle of active involvement in manufacturing and production processes already referred to is absolutely vital.

It is of course possible to gain some understanding of production technologies through observation and participation in workshops or seminars. It is also possible to learn production technologies by learning to manufacture one or two items. No lasting and manufacturing skills and know-how, however, can be gained through these means. Technological knowledge is lastingly gained and improved only when applied. Workshops and seminar papers and presentations and briefings are indeed useful media for transferring industrial knowledge. Yet for the most successful and lasting transfer of manufacturing and other technologies relevant to industrial development, consistently executed programmes of designing and manufacturing technologically viable and economically feasible products are better media.

Having discussed the phases of technological transformation, let me now turn to what I call the "vehicles" of industrial transformation.

Vehicles for Industrial Transformation

Only through a programme is the transfer and development of technology possible. Therefore, programmes for the design and manufacture of concrete products are *conditio sine qua non* for any effort to achieve technological advancement. Not all programmes, however, are equally appropriate for a country's industrial transformation.

In principle, any programme involving production technologies for the manufacture of any product in any sector can be chosen as a medium for the transfer and further development of technology through the three phases suggested. But for programmes to be able to launch a developing country into a sustained process of transformation into a technologically and industrially developed nation they must satisfy two critical requirements.

The first and necessary condition is that the programmes must be made amenable to the design and implementation of progressive manufacturing plans. This means that it must be possible to decompose the programmes into steps permitting a progressively deeper penetration of the technology used. In this context penetration of technology is measured by the proportion of domestic added-value in the total product manufactured while progression is measured in terms of numbers of units produced. Progressively deeper penetration therefore signifies that the amount of domestic added-value must increase with the number of items produced. It is true of course that the degree of decomposition of manufacturing programmes in each case depends on the degree of human and capital investment required in relation to what is feasible in terms of engineering capability at a given time and place. The aim of progressive manufacturing plans is to improve the technological capability of the producing firm into a stage in

which it is able to manufacture the same percentage of added-value as is normally produced by comparable firms in any industrially developed country. For airplane manufacturers, for example, the percentage of value-added by the firm is typically around 40 to 60 percent of the value of the product since it is more economical to purchase many parts and components from other more specialized companies as vendor items.

The second and sufficient condition for a programme to perform the function of a vehicle for technological and industrial transformation is that their products must fulfill the requirements of the market. In developing countries with a limited domestic market for the products or product groups chosen, programmes must meet the conditions necessary to make the products competitive on the world market. In developing countries with a large domestic market for the products chosen, the technologies must make the products competitive on the domestic market.

For developing countries with a limited domestic market for aircraft—for instance, programmes for the production of propellers, or undercarriages, or aircraft engines would not be an appropriate way to launch viable technological and industrial progress. They could, of course, transfer even the most sophisticated technology for this purpose so that in time, these countries would be producing excellent propellers, undercarriages and airplane engines. At such a time, however, the firms manufacturing these products would have to face enormous marketing problems. Since there would be no demand for these products in their own domestic market, the firms would have to enter the world market and counter the competition of other companies with years of sales experience, international contacts and vast financial and managerial strength. Even with excellent products, it would be very difficult for these firms to compete. Programmes like these therefore, are not the proper vehicles for their countries' transformation into a technologically and industrially developed nation, not because the technologies involved are primitive but because of the lack of a direct link between the programme and the requirements of the domestic market. Given a large and controllable domestic market it would be unwise for Indonesian companies to implement manufacturing programmes without any relation to this market. Unlike countries like Singapore and Hong Kong which have no other course but to enter the world market directly, countries like Brazil and Indonesia can and should orient themselves to the demands of their own domestic markets in defining and implementing the most appropriate programmes for their transformation.

Several requirements must be fulfilled for products to be offered on the market at competitive prices. First, the scale of production must approach the optimum. Second, the quality of the products and the after-sales service must be reliable. In order to achieve these conditions it will in many cases be necessary for firms to be given temporary protection. Optimum scale of production cannot be obtained if sales are limited to very small numbers of production because markets are overcrowded. Manufacturing and servicing skills do not develop overnight after having produced a few items. Therefore, although we all agree that in the final event producers must be able to compete in the free market, it is in order to enable firms to achieve competitiveness in the long run that they must in many cases be given protection in the short run. For obvious reasons, this protection can be provided only in domestic markets. It is for these reasons that in the effort to nurture certain products or product groups to fulfill their role as vehicles for industrial transformation they are given temporary protection.

When scale is achieved and the required skills are established protection is released and the vehicles are launched to compete on their own strength in the domestic as well as the world market.

Several questions may at this point arise: If the ideas in the foregoing appear valid, how would their application be in concrete cases? What would be the vehicles and what programmes would be undertaken?

In answer to these questions, allow me now to progress from the general and the abstract to the specific and the concrete and use Indonesia, where these ideas are currently being implemented, as an example.

Phase and Vehicles for Transformation: The Case of Indonesia

What products or product groups constitute the proper vehicles for each particular country and what phases of development should be undertaken in each product group depends on the particular circumstances in each case.

In Indonesia, the product groups selected were chosen on the basis of factors such as geographical size, strategic location, present and future size of its domestic market and our perception of the political scenario in the Southeast Asian area today and in the time to come. With 13,000 islands stretching over an area from west to east as far as San Francisco to New York or from Ireland to Moscow, with a present population of 156 million and by the end of this century, 200 million people, a strategic location on main shipping routes between the Indian and the Pacific Oceans, and in the long run growing per capita income, the following industries appear to be the natural vehicles for Indonesia's transformation.

Given Indonesia's size and composition and the need to strengthen political integrity and to develop a unified national economy, the whole transportation equipment sector is an obvious choice: the aircraft industry, the maritime and shipbuilding industries as well as automotive and rolling stock manufacture. These industries plus electronics and telecommunications are the most logical vehicles in which to transfer and develop, in twenty years' time, all the necessary technologies through the three and perhaps the fourth stage, as well. Through their development, employment will be created. Incomes will rise and markets will grow. Indonesia's human potential for economic growth will be developed. And given the fact that energy consumption rises with income, the whole energy industry is another promising vehicle: this includes the manufacture of turbines, boilers, generators, heat exchangers, etc. as well as energy transport and transmission equipment. With growing needs for facilities for the processing of Indonesia's agricultural products and mineral and energy resources: sugar, palm-oil, petrochemicals, cement, etc., the engineering industry also appears to be an appropriate vehicle for Indonesia's industrial transformation. A seventh vehicle is the agricultural equipment industry. With land on Java increasingly scarce, agriculture on poorer soils and more limitations on labor, islands outside Java must be increasingly developed. This requires increased mechanization of agriculture, both pre-harvest as well as post-harvest. Lastly, after having invested large amounts of capital in these industries and thereby given rise to increasing wealth, given Indonesia's strategic location and her vast reserves of natural resources, there is greater need for a domestic defence industrial capability. At the same time, the development of the aircraft, the shipbuilding and the land transportation equipment industries imply the development of weapons and weapon-systems platforms.

With the growth of these industries, other sectors of Indonesia's economy will also expand through many backward and forward linkages: road construction, housing, food production, agro-industry, pharmaceuticals, and all kinds of services, including health services. Moreover, industries which at first would not be appropriate vehicles such as the production of engines, propellers, undercarriages, hydraulic systems, bogies for railway cars would become economically feasible because of the creation of their markets. All these industries together can be regarded as the "invisible" ninth vehicle.

In the improvement of our technological capabilities in these sectors, most of the first- and second-phase development programmes are undertaken by industry while third- and even fourth-phase programmes are undertaken by the PUSPIPTEK Center for the Development of Research, Science, and Technology in Serpong near Jakarta and other research and development centers. When fully completed, PUSPIPTEK's facilities will include a construction testing laboratory; an aerodynamics, gasdynamics and vibrations laboratory; a thermodynamics and propulsion laboratory; a process technology laboratory; a physics laboratory; an electronics laboratory; a chemistry laboratory; a calibration and instrumentation laboratory; an energy laboratory; a metallurgical laboratory; and a multi-purpose research reactor with its supporting laboratories.

The development of all these industries and the creation of these laboratories point to a scenario for Indonesia's transformation from a predominantly agricultural country today into a technologically and industrially developed nation in the future.

Additional employment and wealth would be brought into being. In addition to her vast natural wealth Indonesia would be endowed with immense reserves of renewable human resources.

A final question may now have arisen, the question about the implementation of these ideas in actual practice. I would now like to turn to this question.

Application in Indonesia

Aeronautics and Aerospace

In this industry, the first phase was implemented in 1976 with the manufacture of the NC-212 two-engine, 19-passenger STOL airplane under license from the Spanish firm of Construcciones Aeronauticas SA (CASA) and the NBO-105 helicopter under license from Messerschmitt-Bolkow-Blohm. Today, PT NURTANIO Indonesia Aircraft Industry is the licensee of four helicopters, the BO-105, the 10-passenger MBB-Kawaski BK-117, the 15-passenger Bell Textron Bell 412, and the 24-passenger SUPER-PUMA from France's Aerospatiale. The progressive manufacturing plan is used in the manufacture of all these crafts. In 1976, PT NURTANIO started operations with an employment of 500. Today, PT NURTANIO employs 8,500 persons. When we began, less than ten percent of the components were produced domestically; today, it is ninety percent. After four years of operations, this product group was declared a vehicle for Indonesia's industrial transformation.

Today, we export aircraft to Thailand. Our prices are the same as that of our licensors. The quality of our products is the same as theirs. We are internationally competitive.

The second phase in this industry began four years ago with the creation of Aircraft Technologies Corporation (AIRTEC), a joint venture formed by PT NURTANIO and CASA each having fifty percent share, to design and manufacture prototypes of the CN-235, a new two-engine, 35-passenger aircraft. The roll-out of the prototypes

is planned for September this year with flight-testing for FAA-certification beginning the following October.

There is an overlap between the second and the third phase in the development of this industry for even in the second phase new components are being integrated into the new aircraft. The prototypes of the airplane will undergo static and dynamic tests at the Construction Testing Laboratory of the PUSPIPTEK Center for the Development of Research, Science, and Technology to which I have referred to earlier. Other PUSPIPTEK facilities to be involved in the CN-235 programme are the aerodynamics, gasdynamics and vibrations laboratory, the electronics laboratory and the calibration and instrumentation laboratory.

The next phase in the development of the aircraft industry may take the form of the development of new jet aircraft such as larger passenger craft, trainers and fighters.

These developments demonstrate that in the span of seven years this industry has proven itself to be a feasible vehicle for Indonesia's transformation into a developed country.

Indeed, our experience shows that this vehicle is not only feasible but that it is also economically viable. With accumulated investment costs of approximately 85 million US dollars and a working capital of around 140 million US dollars, PT NURTANIO has since its third year of operations been profitable. By 1982, accumulated net profits were about 9 million US dollars.

Even in the first phase what I have called the ninth vehicle began to emerge. Today, in this industry alone a market has been created and/or widened for one hundred and sixteen domestic companies. One firm which started out with five people now has two hundred persons on its pay-roll. Others are now working together with international partners supplying components to PT NURTANIO.

It is true that this rapid advance has been achieved under the conditions of a protected market since with the declaration of this industry as a vehicle for transformation in 1980 the import of aircraft of similar classes as those manufactured by PT NURTANIO has been restricted. However, this protection has had the result of creating, for the first time in the market's history, the degree of standardization which has made it possible for the industry to manufacture at scales of production permitting it to be internationally competitive. And because we believe that ultimately, it is the market which is the best arbiter of business performance, in time we will open our market to international market ourselves for all our products.

Maritime and Shipbuilding

At the present moment, the maritime and shipbuilding industry in Indonesia is dominated by eight shipyards, of which PT PAL, a government-owned company like PT NURTANIO, is by far the largest.

Today, this industry is in its first phase of transformation with the production by PT PAL, PT Pelita Bahari, another government corporation, and PT Intan Sengkunyit, a private company, of 3,500 ton tankers for which the designs were purchased from Mitsui Engineering Company. Other programmes include the production of 3,000 dwt general cargo vessels by PT PAL in cooperation with Mitsui. For Indonesia's defense purposes, PT PAL will commence with the manufacture of 400-dwt, 30-knot FPB-57, and 60-dwt, 30-knot FPB-28 petrol boats under license from Friedrich Luerssen Werf in Bremen, and with Boeing Marine Systems, of 50-knot jet-foils, vessels produced with

the latest state of the art technology, with differing configurations. In all of these programmes, except for the building of the 3,500 dwt tankers which is fully Indonesian, progressive manufacturing plans are in force to ensure the gradual transfer of technology.

In cooperation with Mitsui Engineering Company, PT PAL is also enlarging and improving its dry-docking, maintenance and overhaul capabilities to serve Indonesia's growing fleet and is developing the capacity to build ships of up to 30,000 dwt.

In this industry, the second phase of transformation will not be far off with PT PAL performing the function of taking the lead in developing technology and disseminating the results to the other companies.

Land Transportation

Two sub-sectors of this particular industry are of particular interest at this moment, the automotive industry and the rolling stock industry, with both in the first phase of development.

For historical reasons the automobile industry is largely privately-owned with six groups of local assemblers, manufacturers and dealers operating jointly with major European, Japanese and United States firms. Although privately-owned, all groups will follow the pattern of transformation I have described. Commencing in 1979, a rationalization of the industry was undertaken reducing the number of makes from 57 to 30 and the number of types from 140 to 72 by 1980. Priority is given to the assembly of commercial rather than personal-use vehicles with an overall national ratio of 8 to 1.

Sole agents-assemblers of commercial vehicles are also required to use domestically produced components such as tires, paint, accumulators, shock-absorbers, leaf springs, and safety glass, as well as rear bodies, fuel tanks, chassis, and cabins. By 1986, all components used in the manufacture of the products of the automotive industry will be made in Indonesia. The same policies are enforced in the two-wheel vehicle industry in which 9 companies are active assembling, distributing and manufacturing components for 6 makes.

In the automotive components industry the Government has studied the feasibility of developing the manufacture of petrol and diesel engines, axles and propeller shafts, and steering systems. PT Spicer Indonesia, for instance, has obtained government permission to produce axles and propeller shafts under license from Dana Corporation, a US firm.

The rolling stock manufacturing industry is controlled by a single government-owned corporation, PT Industri Kereta Api (PT INKA). Major programmes of PT INKA today is the manufacture of 150 units of coal-cars, another 250 units of tank-cars, to be completed this year, and up to 2,400 units of freight cars under license from Nippon Sharyo a corporate member of the Sumitomo group of companies. The production programme for 1985 and 1986 include 126 units of passenger cars, an additional 344 units of coal cars, 200 units of fertilizer freight cars and a total of 766 units of freight cars for various other purposes. Again, progressive manufacturing plans are implemented in all programmes.

Recently, with Nippon Sharyo, PT INKA has submitted a joint bid for the delivery of freight cars to Thailand. This will be the company's first test of its competitiveness in the international market.

With the development of the rolling stock manufacturing industry, the market for its components has correspondingly widened giving rise to the prototype production of casted bogies by PT Barata Indonesia. The progress made by PT INKA has also attracted the interest of foreign companies such as Messerschmitt Bolkow-Blohm, Linke-Hoffman-Busch and Sadzgitter AG from Germany, and Holec from the Netherlands to cooperate with the company.

Telecommunications

Three sub-sectors are being developed in this industry: the consumer electronics industry which, like the automotive industry in Indonesia, is largely private; the utility telecommunications industry manufacturing communications satellite ground station equipment, telephone equipment, etc., in which government-owned enterprises play a major role; and the cable and wire industry also largely privately-owned.

This sector is also in the first stage of development.

Major programmes being implemented include the manufacture by PT INTI, a government corporation, of digital telephone switching systems under license from Siemens. An evaluation is currently being made for the concluding of a second licensing agreement between PT INTI and another company for the same type of equipment. Contenders include among others Phillips, France's CIT ALCATEL and the US-Belgian Bell Telephone Company. The firm is also cooperating with the Japan Radio Corporation in the manufacture of automobile telephones, and with VIZ of the United States in producing radio wind sondes. The National Electronics Institute, a government research organization, is developing defence-related communications system as well as short-wave 100 KW and 250 KW radio transmitters, 50 W to 10 KW television transmitters, and satellite television receivers. The privately-owned Radio Frequency Company manufactures various types of radio receivers, multiplexers, television transmitters and translators as well as radar under license from the Atlas-Krupp company. All three companies, PT INTI, the National Electronics Institute and Radio Frequency Company, produce components for satellite ground stations under license from International Telephone and Telegraph Company, Nippon Electric Company and others. PT INTI, for instance, has completed 20 small ground stations for domestic uses and is on contract with Malaysia for the construction of, in the first phase, 6 small ground stations. Under contract with the International Telecommunications Union, PT INTI will construct a package satellite data communication network to be operational this year.

Present capacity of the cable manufacturing industry include duct cables, jelly filled cables, underground cables, electric wires, automotive wires, and other products.

The Energy Industry

Given Indonesia's projected growth in the demand for tertiary energy, mechanical power and energy transport there is vast scope for investment in the energy industry: the manufacture of boilers, turbines, generators, heat exchangers, energy transport equipment, and machinery.

We conservatively estimate that in the coming twenty years the demand will approach 30,000 megawatt electrical power which implies a volume of business of up to forty-five billion US dollars and are planning for at least one-third participation of Indonesian firms in this business through licensing.

In the boiler industry, present capability comprises the manufacture of industrial boilers of up to 100 ton/hour steam generating capacity while industrial boilers with larger capacities and utility boilers are still being imported. Firms active in the boiler industry include PT Atmindo, a licensee of Bardet Babcock and Deutsche Babcock, PT Super Andalas Steel, licensed by Takuma Boiler to manufacture boilers of up to 80 ton/hr capacity, PT Boma Sork, a Brownsverk Utrecht licensee, PT Barata, a Combustion Engineering-Lummus Company licensee for the manufacture of erection boilers of up to 200 MW. PT Barata Indonesia is also CE-Lummus' licensee to manufacture heat transfer equipment of 5,000 ton/year capacity.

In water turbine manufacture, present Indonesian capability has reached 1,400 BHP.

Two electric generator manufacturers are in operation in Indonesia today: PT Denyo from Japan and PT New Age Engineers Indonesia, producing generators of up to 1,000 KVA in cooperation with the British firm of Stamford.

Electric generator diesel engine manufacturers include PT Boma Bisma Indra producing Deutz and PT Mesindo Agung manufacturing MWM engines both from West Germany.

As is the case with the other industries also in the vehicle, control of the market does not necessarily mean the predominance or monopoly of government enterprise.

The Engineering Industry

The engineering industry also has large potential in Indonesia, producing components for sugar factories, paper mills, fertilizer plants, etc.

In the sugar industry alone, this is a market for ten factories which is produced at the rate of one every two years, will provide component manufacturers work for twenty years. We are therefore preparing PT Barata Indonesia, to work together with Kawasaki in a first-phase development programme in this field. Barata will also be specialising in manufacturing equipment for the paper-mill industry. PT Boma Bisma Indra will be geared to serve the petrochemical industry, while other firms will be prepared to specialise in other selected fields. In addition to these government corporations, private firms are also active in this industry.

Many government and private companies are also active in the software business of project management and engineering. Present capacity reaches 210,000 man-hours a month with for instance, PT Panca Perintis Indonesia working together with Fluor of the United States on the Cilacap Refinery project, PT Purna Bina Indonesia in partnership with Bechtel also from the United States working on the Bontang LNG-project, and PT Barata Indonesia being the main contractor for the Baturaja Sugar Factory.

As in the case of shipbuilding, there is scope for the participation of a sizeable number of firms in this industry. Thus it has appeared more efficient to establish a single separate company, i.e. PT Rekayasa Industri, expressly for the purpose of leading the second phase of the development of this industry by undertaking the tasks of designing new products and integrating components into the new product with component manufacture being undertaken by other companies.

Agricultural Equipment

With presently projected rates of growth of the Indonesian economy, agriculture will remain a very important sector in terms of contribution to GDP and employment. The

scope for manufacturing both pre- and post-harvest agricultural machinery and implements is correspondingly very large.

Except for large tractors, domestic industry has developed sufficient technological capability to manufacture equipment such as hand tractors, mini-tractors, irrigation pumps, sprayers, rice-threshers, -hullers, -polishers and -milling units, etc., and implements such as plows, levellers, floating wheels, and rotors, both of foreign as well as of domestic design. Most manufacturers, assemblers and sole sales agents are privately owned.

The Defence Industry

In addition to what has been said with regard to the production of patrol boats by PT PAL and the manufacture of helicopters by PT NURTANIO, both companies plan to be active in the defence industry with the possible design and manufacture of jet trainers and fighter aircraft by PT NURTANIO in a third-phase development of the aircraft industry, and the future production of 2,100 dwt frigates and minesweepers by PT PAL.

The weapons systems division of PT NURTANIO will also manufacture AEG Telefunken SUT torpedoes and Belgian 2.75" FZ rockets.

PT PINDAD, a government company, in a first-phase development programme will manufacture FNC rifles firing SS-109 5,56 mm bullets under license from the Belgian firm of FN Herstal. Also with FN Herstal, PINDAD will manufacture various other caliber ammunition and non-guided missiles as well. Other PINDAD programmes include mortars and grenades.

PINDAD's technological and manufacturing capability will also be used for non-defence related production programmes such as the manufacture of engine components, transmissions, steering wheels, front axles, and ship components in cooperation with Rheinstahl Technik in forging technology; the production of industrial tool machinery with the DIAG Group; and the production of various tools and jigs.

The Role of the Agency for the Assessment and Application of Technology

In the evaluation of sectors of industry for their potential as vehicles for Indonesia's transformation into a technologically and industrially developed nation; on the definition and monitoring of first-, second- and third-phase development programmes; in the selection of potential partners for Indonesian firms; and in the selection, preparation and supervision of Indonesian companies engaged in the various phases of transformation of their industries; the Agency for the Assessment and Application of Technology plays a crucial role.

It is this Agency which guided and monitors the implementation in Indonesia of the concept of technological and industrial transformation I have described, and which assesses the interconnections between technology, industry and other areas of Indonesia's national life.

Established in 1978 by Presidential Decree Number 25 and recently reorganized by Presidential Decree Number 31 of 1982, the Agency has the tasks of advising the President in matters of national policy with respect to the development and application of technology for national development; of coordinating the implementation of technology development and application programmes; of providing advisory and consulting services to government agencies and to the private sector; and of implementing technology development programmes.

Governed by a Chairman who is concurrently Minister of State for Research and Technology and a Vice-Chairman, the Agency has twenty directorates and four bureaus reporting to six Deputy-Chairmen. These are:

- the directorates of basic sciences, of life sciences, of engineering sciences, and of marine sciences reporting to the Deputy Chairman for Basic and Applied Sciences;
- the directorates of human settlement and environmental technology, of industrial process technology, of energy conservation and conversion technology; of electronics and informatics, and of physical facilities and laboratories; reporting to the Deputy Chairman for Technology Development;
- the directorates of machine and electrotechnical industries, of processing and engineering industries, of defence and strategic industries, and of industrial infrastructure; reporting to the Deputy Chairman for Industrial Analyses;
- the directorates of natural resources inventory, of mineral resources, and of non-mineral resources; reporting to the Deputy Chairman for Natural Wealth;
- the directorates of operations research and management, of systems analyses, of technological regulation, and of simulations and modelling; reporting to the Deputy Chairman for Systems Analyses;
- the personnel, education and training bureau, the finance bureau, the bureau for legal affairs and public relations, and the bureau for supervision and control; reporting to the Deputy-Chairman of Administration;

In addition the Agency has the following Technical Operations Units:

- the Construction Testing Laboratory; the Aerodynamics, Gasdynamics and Vibrations Laboratory; the Thermodynamics and Propulsion Laboratory; the Energy Laboratory; the Processing Technology Unit; the Ethanol, Single-Cell Protein and Sugar Unit; the Hydro-Electrical Unit; the Coal Processing Unit; the Transportation Systems Unit; the Defence Industries Unit; and the Social Sciences Unit.

As can be seen, the Agency's technical operating units include those facilities of the PUSPIPTK Center for the Development of Research, Science, and Technology which have been completed. And as has been said earlier, while most of the first- and second-phase development programmes as well as some of the third-phase development programmes are undertaken by industry, the Agency itself implements many third-phase development and prepares the execution of most fourth-phase programmes. Many of these are being executed jointly with research and development organizations both in Indonesia as well as abroad.

Summary and Conclusions

In the context of nation-building which I regard essentially as the effort to develop a people's human potential to produce goods and services of benefit to themselves and to the world, to protect their potential integrity and to advance their cultural endowments, the transformation of a society into one which is technologically and industrially sophisticated is a vital process. For this transformation the improvement of scientific and technological skills is central.

I have approached the problem of achieving this transformation from the point of view that while education is very important, it cannot be sufficient. For science and

technology skills are only transferred and further improved through concrete programmes of producing goods and services.

One can conceive the process of technology transfer and development as consisting of three overlapping phases: the use of existing technology for added-value processes: the integration of existing technologies for design and manufacture of new products, and, the development of new technologies. A fourth phase can also be identified. This phase, crucial for the maintenance of scientific and technological prominence and of particular relevance to developed industrial countries is the phase of basic research in order to advance scientific knowledge itself.

In theory, any programme can function to transfer and develop technology. Not all programmes, however, are the proper vehicles for the technological and industrial transformation of developing countries. To become vehicles they must fulfill certain criteria.

The first and necessary condition is that progressive manufacturing plans can be designed and implemented permitting a step-by-step penetration of the technology. The second and sufficient condition is that the products or product groups must have a demand on the controlled domestic market.

The products or product groups appropriate to qualify as vehicles for the transformation of a particular country are determined by its geography, its factor endowment, the growth of its economy, the size of its domestic market, and other factors. For Indonesia, the following eight industries have emerged as the vehicles for the transformation of the Indonesian people into a nation masterful in technology and proficient in industry. These are: aeronautics and aerospace, shipbuilding, land transportation, electronics and telecommunications, energy, engineering, agricultural mechanization equipment, and the defence industry. The very growth of these eight vehicles have through many forward and backward linkages, engendered the growth of what I have called the ninth vehicle: all kinds of service industries, including health services; housing; construction; food; agro-industry; pharmaceuticals; component manufacture; etc.

Finally, by describing the developments in the industries defined as Indonesia's vehicles, I have attempted to demonstrate that the ideas I have presented are being implemented in the guiding and controlling a country's technological and industrial transformation.

The fact that technological and industrial development in Indonesia is subject to guidance, supervision and control does not mean that private initiative is stifled. Indeed, as I have shown, in all the vehicles for our transformation there is vast scope for private enterprise. For Indonesia does believe in the efficacy of the market economy. As is also evidenced by our conclusion of agreements of cooperation in science and technology with the United States in 1978, with the Federal Republic of Germany and with France in 1979, and with Japan in 1981, we highly value our close economic, political and cultural relations with any country and any party willing to be our partners on the basis of mutual respect and interest based on the philosophy and the concepts I have presented to you today.