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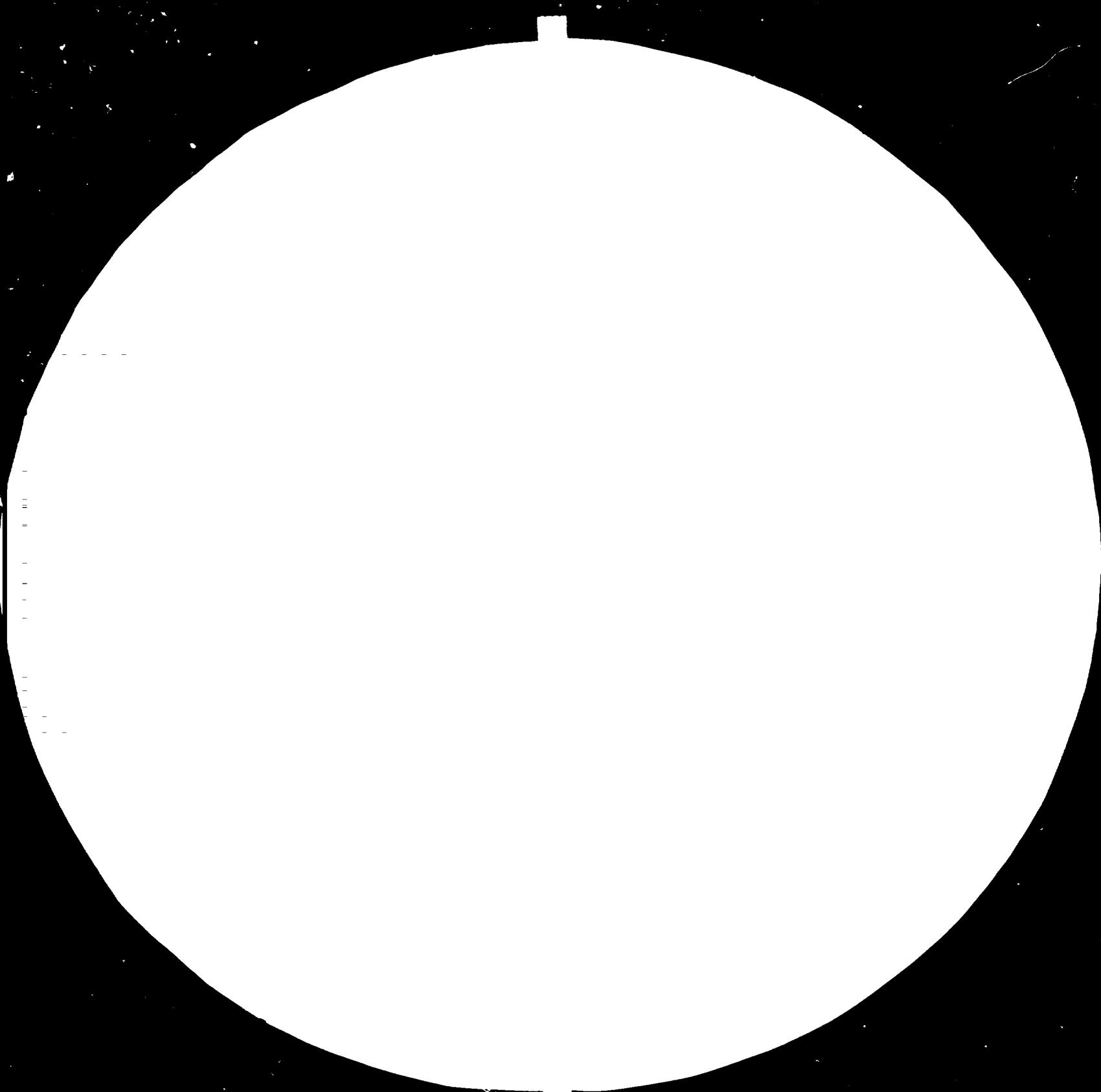

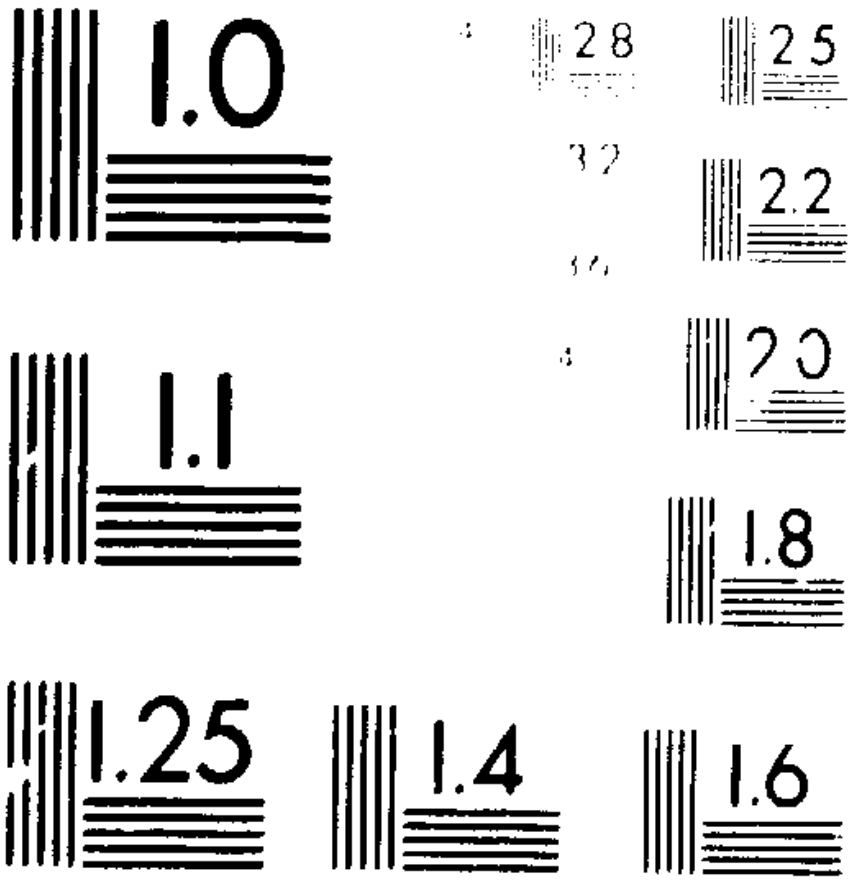

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29 October 1984

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RECENT INTERNATIONAL TRENDS IN ENGINEERING INDUSTRIES AND ISSUES FOR CONSIDERATION IN THAILAND

Note prepared by the

Regional and Country Studies Branch

Recent International Trends in Engineering Industries and Issues for Consideration in Thailand

I. Trade and Production of Engineering Sector

1. The Engineering Industries (EI) are defined to cover ISIC categories 381-384 (production) and SITC group 7 (trade); the main subsets of EI include fabricated metal products, electrical and non-electrical machinery, and transport equipment.

2. For the 42 countries of the world for which EI exports are of some significance, aggregate exports in 1982 totalled approximately $ 490 bn with an average annual growth rate 1970-82 of just over 15%. EI trade accounts for some 23% of world trade, though for the OECD countries its share of their exports is much higher at around 39%.

3. Developing countries (DC) exports of EI are, at $ 12 bn, less than 3% of the global figure and the major share of them comes from a mere handful of countries, particularly Argentina, Brazil and Mexico in Latin America, and India, Republic of Korea, Hong Kong and Singapore in Asia. For most of these countries, non-electrical machinery is the principal category.

4. Production figures (less up to date than trade) put world EI output in 1980 at around $ 780 bn of which DC account for roughly 6%. Despite rapid growth through the 1970s in larger DC (e.g. compound rates of 35% p.a. in the Republic of Korea, 13% p.a. in Brazil), the output remains quite small compared to significant OECD manufacturers - Brazil, India and Republic of Korea together, for example, only produce some 25% more than Sweden. For countries in Asia, some impression of the weight of EI in exports and production can be gained from 1981 figures (see Table 1).

By comparison, the equivalent production share in USA in 1981 was 33% and the range for all 'core' OECD countries 30-40%. Taking EI as a whole (i.e. including fabricated metal products), the US at end 1970s had some 38% of manufacturing value added in EI - this is the 1991 target share for the Republic of Korea.

Table 1. Machinery and Transport Equipment in Production and Exports of Selected Asian Countries, 1981

	Production (% of Manufacturing Value Added)	% of Total Exports
Thailand	15	5
Philippines	10	3
Republic of Korea	18	22
Singapore	55	22
Malaysia	18	12
Indonesia	7	1

5. The heterogeneity of EI renders generalities about its production structure hazardous. As an illustration, Table 2 offers a disaggregation (late 1970s) for Sweden according to the four main ISTC headings.

Table 2. Some key data on the Swedish metal-working and engineering industry 1977 (ISIC 38), 385 and 3841 (shipyard) are excluded

	Industry				
	Metal products ISIC 381	Non-electrical machinery ISIC 382	Electrical machinery ISIC 383	Transport equipment ISIC 384	Total %
Establishment	44	31	11	11	100
Employment	21	32	21	22	100
Capital stock	26	40	13	21	100
Sales value	20	32	19	29	100
Investment 1974-1980	23	32	20	25	100

These figures suggest that non-electrical machinery carries the most weight according to major economic criteria though, not surprisingly, relatively more production establishments are in the metal products area.

6. Later in this note, it is argued that EI is a focal area for the introduction of new technologies. Using again the Swedish example, Table 3 indicates the end 1970s distribution of the stock of numerically controlled machine tools (NCMT), robots and computer aided design/computer aided manufacturing systems (CAD/CAM).

Table 3. Percentage distribution of NC-machines, robots and CAD/CAM-systems in Sweden 1979

	Industry				
	Metal products ISIC 381	Non-electrical machinery ISIC 382	Electrical machinery ISIC 383	Transport equipment ISIC 384	Total %
NCMTs %*	23	44	20	13	100
Robots %*	53	15	9	23	100
CAD/CAM system %**	10	15	50	25	100

* The classification of NCMTs and robots is done by workplace and not by enterprise. This is of importance as one firm may produce goods in several ISIC groups.
** Rough estimate.

Differences in the pattern of use are striking - robots in metal-working, CAD/CAM in electrical machinery and NCMT in the non-electrical machinery field. It appears that larger companies are the ones making heaviest use of the new technologies. Size of firm is nevertheless not the only determinant of speed of diffusion - type of product is also significant. For this purpose a simple fourfold classification can be used i.e. consumer goods (e.g. bicycles, automobiles, radios), investment goods (e.g. trucks, diverse kinds of machinery), components (e.g. ballbearings, electric motors, pumps) and goods consumed in the production process itself (e.g. cutting tools). On this basis, an assessment of automotion tendencies in Sweden as of the early 1980s yielded the following results:

Table 4. The tendency to automate by product type, by NCMTs and by robots

	Type of product			
Equipment	Consumer goods	Investment goods	Component goods	Consumption goods
NCMTs	very low	medium	high	high
Robots	medium	very low	high	very high

The tendencies are sharp: component and consumption goods are highly susceptible to quick introduction of the new technologies. The consumption goods are, in most cases, items characterized by large production volumes and relatively standardized; the former is also true of components, though they tend to be less uniform. Since both categories refer to key elements of production processes, the implication is that the ways of manufacturing these items are now altering dramatically. It may be expected that producers in DC will come under growing pressure to maintain their sales of these products. By the same argument, the fact that these innovations tend to reduce both capital and labour intensities of production weekens incentives to establish plants in DC themselves. Hence not only will domestic producers suffer, but the prospects for 'compensating' foreign investment will be small. There is, of course, another side to the coin, viz. that these innovations could <u>potentially</u> bring substantial benefits to local EI producers. To realize that potential would require radical changes in organization and technical training which have yet to be undertaken: as of now, it seems DC are in danger of suffering the adverse effects without organizing to keep the benefit.

II. EI in the Policy Framework

7. The crucial position of EI in industrialization strategies scarcely requires emphasis. Among the distinctive features of the sector are:

- A channel for the absorption of foreign technologies and the development of domestic capabilities
- A nucleus of practical, on the job training
- The pivot of subcontracting systems and thus of inter-industry linkages
- The combination of large, multifaceted enterprises with tiny workshops, all operating under the same broad umbrella but perhaps with only the former group coming within the realm of government policy actions
- The significance in demand for products and services of projects, i.e. ad hoc activities which often impose heavy requirements both on local supply capabilities and foreign exchange outlays
- Nerve points for the introduction of new technologies embracing such areas as materials (e.g. high grade steels, reinforced plastics), information and control systems (now altering extremely quickly under the impact of advances in microelectronics), and design techniques (likewise undergoing dramatic transformation via microelectronics).

8. Since at least the second half of the 1960s the question of devising and implementing policies for the development of domestic engineering capabilities in DC has been a permanent preoccupation of governments. No single approach has been used with entirely satisfactory results, but the experience gained, especially in Asia and Latin America, permits identification of a few problem areas:

- The diversity of EI, both in terms of the range of products produced and processes employed as well as the breadth and resilience of the enterprises involved, compels a government to acquire a considerable knowledge of the sector before policy measures are launched. This circumstance appears to be one reason why several governments in DC have been reluctant to do anything other than create some technical institutes for training and product testing. In other cases, however, the attitude of the public authorities has been to recognize that a slow learning process is the only real option and therefore to establish multiple mechanisms for a constant dialogue with firms and industry associations

- A conscious strategy for incorporating engineering knowledge is the only way through which local firms can strengthen their capabilities. In practical terms this has meant that some DC, particularly the medium to large Latin American nations, have tried to implement schemes for disaggregation of complex industrial projects, using them as a platform for the mobilization and improvement of local engineering groups. It has been found that such approaches require on the one hand sustained government support, especially through government procurement procedures (i.e. obliging local purchase of specified items) and evaluation of technology transfer arrangements, and on the other a major effort at mapping the local industrial structure in considerable detail (so that potential domestic sources of supply for engineering products and services can be identified)

- Financial mechanisms seem to be a crucial aspect of government policy. It is by no means adequate for a protectionist tarrif system to be set up, and then to leave firms to their own ways. Rather, the pattern of demand for important segments of engineering production suggests that credit policy to help firms overcome the leads and lags in orders can be a great help, while attempts to win international contacts for supplying engineering products can usually not succeed unless the local enterprise can offer supplier credits - only a handful of companies are usually in a position to do this, so the provision of government financial guarantees can be a vital element in winning international bids

- Since the enhancement of domestic skills can hardly be accomplished without foreign collaboration, various governments in DC have found it necessary to focus on ways of organizing that collaboration. One simple method which has had some success is the organization of joint ventures in the area of project engineering. The aim is first to bring domestic firms into the construction phases of projects (which on the average account for around one third of investment costs), and then gradually move towards local involvement in more advanced parts of a project, the eventual hope being to attain some domestic capability in basic engineering and design. Sometimes local private firms have been the best vehicles to carry out the joint venture, but there are also several examples where public sector organization of collaboration has been the most suitable method. This is particularly true where DC, on the basis of clearly established priorities for industrial expansion,

have decided to move into complex areas, e.g. petrochemical production.

- It has been found that, due to the role of international financial agencies in the provision of loans for big projects, the conditions set by them for procurement often influence the local engineering participation. Though a developing country on its own finds it hard to get around these constraints, groups of the developing countries sometimes can do so (joint action through ASEAN is an obvious example in the case of Thailand)

- In certain areas of EI, particularly fabricated metal products, component manufacture in the transport field, and simpler forms of electrical goods, there can be appreciable differences in the quality standards applied to items made for replacement market sales as compared to original equipment manufacture. One implication is that while local output may be adequate to meet replacement needs at home, a far tougher task awaits firms trying to supply original equipment for international markets. At that point the decisive quality control is carried out by international firms in their home bases, and local engineering enterprises experience considerable difficulty in making the jump from one market to another

- The dramatic change in the international economic environment over the past few years has posed new problems for the development of EI. Among them the most important seem to be: the emphasis on technological innovation designed to reduce inputs of unskilled labour in numerous production processes; the drive to fully internationalize certain markets of great importance to engineering production, among which motor vehicles and telecommunications are examples; the strategic changes of perspective by transnational firms as they seek to adapt products and processes still more to the market conditions in the OECD core countries; the sharp focus on reducing foreign exchange expenditures and the noticeable tightening of foreign assistance grants; and the increased competition to penetrate DC markets

9. These points are a mere sketch of some of the trends observable. They hint that behind the growth in production and trade which have taken place, particularly in countries of South East Asia, there persist major structural weaknesses which should form a focus for discussion in this seminar:

- The concentration on particular subsectors, such as electronic components, which make heavy use of unskilled labour, have few domestic linkages, and tend to be dominated by foreign firms. All three characteristics suggest that the real contribution to developing domestic industrial strength is far below that which would be gathered from examining aggregate economic data alone

- The very limited capabilities to handle large industrial projects; only a few countries in the region seem to have made noticeable progress in this area

- The focus on export-oriented, unskilled labour-intensive areas of engineering, coupled with the severe deficiencies in engineering design, suggests that countries of the region may be particulary vulnerable to the consequences, in the late 1980s, of the technological changes now occurring on a major scale. It appears that, within the OECD core countries, the conditions are now coming into place for a major reorganization of international production systems (as opposed to the changes which have already taken place in the OECD core itself). If this is so, then the past patterns of international linkages for the countries of the region may not be valid for too much longer. The principal consequence would be that the region would have to look more towards the domestic markets and options, at the same time as launching major efforts to advance quickly in selected areas where engineering technology is changing rapidly

- If these comment are roughly correct, then industrial structure will undergo quite big shifts and with them the role of domestic engineering production, particularly machinery production, will alter. To take one example, the prospects for textile machinery manufacturers would be greatly affected if the changes in the production process now just about ready in the OECD were to penetrate quickly the Asian market

III. The Key Issues

10. The central concerns for government policy thus appear to revolve around two major considerations. First, the imperative need to develop mechanisms of encouraging firms in very different technical, financial and commercial spheres. In no other sector is this problem so acute as in engineering. Second, the increasing requirements of technical knowledge regarding changes in engineering production on the international scale. Those changes constitute a severe challenge; since the countries of the region have, in their contemporary economic policies, tried to link closely with the international market, their attempt to retain that policy course compels them to keep up-to-date in at least some engineering areas. To accomplish that will impose heavy strains not only on technical capabilities but also on the mechanisms of government/enterprise co-operation. It is hoped that this seminar may be able to identify possibilities of meeting those challenges.

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UNITED NATIONS INDUSTRIAL
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SOME ISSUES REGARDGING
PRODUCT DEVELOPMENT AND QUALITY UPGRADING
IN THAI ENGINEERING INDUSTRY

Note prepared by the

Regional and Country Studies Branch

Introduction

One of the characteristics of engineering industry projects is their ability to develop and undergo transformations. The product assortment of a new plant may change considerably over a period of a few years; new designs may open up new markets and fields of operation.

The common denominator of these changes is the spontaneous and progressive up-grading of skills and technology associated with the production process. Development support and assistance should be geared accordingly.

At the enterprise level

The growth of the engineering industry sector, even in the context of import substitution, depends in the long run to a considerable extent on domestic ability to create new designs and develop new products, or adapt foreign designs to local needs and means of production. The individual engineering enterprise where the learning process takes place is the focal point for upgrading skills and technology; institutionally, it can be regarded as an actual or potential source of numerous production activities. Only a limited number of such activities are actually in operation at any one time. Some activities such as using rudimentary techniques or manufacturing crude products may already have been left behind, while others such as pioneering designs and making technical adaptations are in the future.

Technological and design institutes

Technological and design institutes encourage the diffusion of advanced techniques and design, work on the adaptation of foreign technology to local conditions and study some of the economic problems of the engineering industry.

The structure of engineering industry products design and research organizations must be adapted to the level of development of the engineering industry. In general, as mechanical engineering develops within a country, it may prove desirable to increase specialization and to split a single technological and design institution into several specialized branches.

Links with universities

Training of technical and design personnel goes hand-in-hand with this process and involves close links between the institutes and the universities in the country. As production within the sector grows, some members of the research staff must be transferred from institutes to engineering enterprises in order to establish the closest and most direct possible link between technology and production.

Direct ties with industrial production establishments

Design and research institutes cannot function properly unless they maintain the closest possible operation ties with industrial production establishments.

Generally speaking, the engineering industry in Thailand can be divided into indigenous firms and transnational companies. The indigenous firms are rarely large, sometimes of medium size, but frequently small or very small. If a large firm has begun its operations by purchasing know-how from abroad, it will usually have made some arrangements for continuing technological support. Such firms could be placed, from the point of view of the industrial research institute, in the same category as the transnational companies.

Many indigenous manufacturing companies, including such in the engineering industry sector, especially the small and very small ones, are craft-based. These crafts employ age-old techniques and the companies may not feel that there is any need for modern technological support. Indeed, they may not believe that the established process can be improved upon. A discussion with the owner or manager, however, will often reveal that difficulties are being experienced regarding which he had not supposed that the technologist might be helpful.

Sometimes the problems are relatively simple and the technologist is able to deal with them quickly and efficiently. Solutions may only entail, for example, testing raw materials or pdocuts; selecting or calibrating a scientific instrument; repairing a broken instrument; designing some simple equipment; or providing information.

Once a company, particularly a large one, realizes the value of technological help, it might decide to establish a laboratory and to employ a number of technologists. It may be thought that once a company establishes a laboratory of its own it will find no further use for the services of the industrial research institute, but experience shows that this is far from being the case. Technologists from individual companies are often glad to discuss problems with, a seek advice from, the institute. In this way, they form a strong medium for technology transfer to the industry. Furthermore, as private companies seldom have the wide range of equipment and experience that are at the disposal of the institute, they often require assistance in carrying out limited-term work of a specialized character.

The technological work related to product development and quality up-grading generally required by industry falls into the following main categories:

- Testing, analyzing and evaluating raw materials and intermediate products;
- Testing and analyzing finished products for standardization, quality control and certification;
- Carrying out instrument repair, maintenance and calibration;
- Designing equipment (e.g. simple ovens, kilns, mixers and driers);
- Carrying out technical investigations designed to improve the quality of finished products and increase process efficiency;
- Developing new processes for current or new products, at both the laboratory and the pilot plant levels;
- Carrying out techno-economic studies;
- Undertaking engineering design and service work.

Some characteristics of engineering design, testing and product quality up-grading in the Thai engineering industry sector

The World Bank mission of 1979[1/] assessing the technical capabilities and competitiveness of a number of enterprises in Thai engineering industry, paid particular attention to the areas of engineering design, testing and

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1/ "Development of the Engineering Industries in Thailand", World Bank, 17 May 1980.

product quality. The mission noted that, as far as capabilities in engineering design and testing were concerned, these activities were not dependent upon the type of company, whether it was Thai owned or a joint venture. It depended largely on the objectives and backgrounds of the managements. Typically those firms with managements with a formal engineering training appeared to undertake more of design-related activities. In the joint venture companies the basic designs of the products were generally as good as those produced by the foreign partner. They were not, however, necessasrily the latest developments. Some joint ventures undertook no product development whatsoever, relying on the foreign partner to supply all new designs. Others did a little to modify products to suit local market requirements. In many Thai firms the designs are direct copies of imported goods. Most firms involved in copying products were not concerned with the technical specification and requirements of the product; provided it looked the same, they were satisfied.

At a few Thai firms where the management were engineers by training, considerable original design of products was undertaken. Again the basis for the product might be a copy but the technical considerations of performance were understood, and the new product could be designed to meet a customer's specification. Good examples of this were seen in small tractors, sugar mills and transformers. In fact, overall these firms had a greater capability for design than most joint ventures.

This last point is most significant as it is usually assumed that transfer of technology is best achieved by importing it through joint ventures. Very often this stifles original design by the indigenous engineers since the joint venture continually refers to the superior technical knowledge of the foreign partner and may in fact be constrained in the licensing agreement from development of new products. Several Thai-owned and -managed companies have on the expiry of their licensing agreements successfully "gone it alone" and have negotiated technical assistance agreements, covering design, research and development applications for their products with internationally-renowned manufacturers on mutually-advantageous terms and without any restrictive conditions on export marketing which may have been previously imposed under joint ventures.

The World Bank mission also noted an almost complete absence of R+D capabilities in the engineering plants visited (with the exception of one Thai-owned and -managed enterprise).

Another characteristic of the Thai engineering industry is that, generally, the quality of the products manufactured by most Thai companies seems to be significantly lower than that of the joint ventures. The products are mainly for consumption by the local markets. Where exports are made, quality standards are higher. Many of the joint ventures visited by the above mentioned World Bank mission were either supplying the automotive trade or other export markets where high quality standards were specified or imposed by the end user.

The attainment of quality can be expensive, especially when the process plant, machinery and tooling is poorly maintained and possibly unsuitable. It can require considerable numbers of operators just inspecting and rectifying work poorly made in the first place. This was the situation at many companies visited by the World Bank mission; 100 per cent inspection was the norm, that is, every component was inspected after every operation. However, even at a company visited which was employing modern sampling techniques an underlying problem of lack of operator skill was evident. In that company up to 10 per cent of all work was scrapped, mainly due to operator error.

Standardization and quality certification

The Thai Industrial Standards Institute (TISI) has categorized standards into compulsory and voluntary standards. The adherence to the compulsory standards established serves to ensure the safety in use of these products by the public and the effects they might have on the national economy.[1/] Of equal importance are the voluntary standards[2/] which allow manufacturers a free hand to conform with them or not. Many of the Thai manufacturers in the engineering industry field have quickly realized the importance of the TISI standard mark. Still much could be done to further spread the awareness of

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1/ The company standards relevant to the engineering industry cover steel bars for reinforcing concrete and LPG cylinders.

2/ Around 70 such standards which are relevant to the engineering industry have been established.

the importance and benefits of the standard mark both among the public and the engineering industry itself. It has rightly been suggested that a campaign to increase public awareness of the TISI mark be carried out. This campaign should have two parts: (a) A general publicity campaign to inform the public what the TISI mark looks like and what it is for. (b) Assistance to TISI licensees to publicize the fact that their products carry the TISI mark. Licensed manufacturers could be supplied with tags and publicity material about standards, and also given help in creating their own publicity material specific to their particular products.

Another area of great concern is the fact that once TISI certifies the manufacturer's product and permits the use of the standard mark, the manufacturer must take it as his responsibility that the quality of his product continuously meet the TISI requirements.

Of great potential importance is the special programme which has been suggested[1/] to accelerate the fixing of standards relevant to the Thai engineering industries, and particularly to the basic process industries such as forging, casting and plating. Under this programme a list should be drawn up of all the main specifications required for the basic process industries and for particular engineering products selected for targeting under the engineering development project. The roster of standards currently under consideration by the relevant technical committees of TISI would provide the first source for this list, and the directories of American, European, Japanese and Australian standards could be used to fill in the gaps.

Concluding remarks

There have been identified some special problems of the Thai engineering sector which act as general constraints on growth. One is the poor attention to quality control and standards. (Another is the weak condition of many of the basic support industries in the engineering sector, particularly foundries and forges.)

1/ Ref. "The Feasibility of a Project to Develop Engineering Industries in Thailand", Research and Data Resources Co. Ltd, Bangkok, June 1981..

Assistance to the engineering industry may therefore include a programme to improve quality standards. Such a programme, it has been suggested, may include:

- measures to accelerate the issuance of TISI standards relating to engineering industries;
- measures to publicize the TISI standard mark and its importance;
- measures to ensure that the requirements for the TISI standard mark are continuously enforced;
- to increase facilities for carrying out testing work.

It has also been suggested that the private sector can help to create a better domestic and international impression of the quality of Thai engineering goods by advertising the concept of "THAI ENGINEERING" on products which have both good quality and a good reputation in the local and overseas markets.

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DEMAND FOR ENGINEERING PRODUCTS

Note prepared by the

Regional and Country Studies Branch

Demand for Engineering Industry Products

1. A crucial problem for engineering industry (EI) producers in developing countries (DC) is to capture demand, i.e. put themselves on the map as reputable suppliers capable of delivering products of good quality at the right time, and at an acceptable charge. While many small shops, particularly those engaged in metal-working and geared to repair and replacement markets, survive quite well through meeting fairly steady local demand, the demand for EI work related to larger projects and higher quality items is usually oriented towards imports (which in Thailand's case total roughly 50% of annual earnings from exports of all commodities). Consequently the spin-offs which might be expected from greater EI demand in terms of technological upgrading, expanded inter-industry linkages, greater employment and foreign exchange savings are (though difficult to quantify) almost certainly much weaker than they should be. Put another way, the multiplier effects of an expansion in EI demand tend to go abroad rather than to domestic suppliers.

2. The question is therefore: what are the possibilities of breaking down the external bias of demand? This note is intended simply to indicate what may be some of the issues involved in finding an answer to that question. The position taken is that the present period provides a confluence of conditions which virtually compel the administration to formulate and implement a strategy for encouraging demand for locally produced EI items. Unless this is done chances are that local content (LC) will go backwards rather than maintain present levels. The conditions in question are:

- o technological advances in OECD countries which are likely, by the end of the present decade, to revolutionize production processes in areas where Thailand's manufacturing sector has been concentrated e.g. textiles, garments, transport equipment. Since it appears unlikely that their industry would be able to insulate itself from the introduction of new equipment and methods, demand for domestically produced machinery in these areas is bound to be affected

- o a renewed effort by enterprises in OECD countries to sell EI products in DC markets, due to slow growth of demand in the OECD itself for many of the more traditional items. Indeed, the surge in demand for

the new products may encourage extra sales pressure for EI items whose economic life is now shortened

- o the initiation of a major drive for big investment projects located on the eastern seaboard. These create a unique 'bunching' of investment expenditures which are quantitatively enormous, likely to be maintained over a long period, contain a substantial element of public sector outlays, and yield a fair proportion of EI products which are common to the diverse projects (i.e. even where sectors for the projects differ, construction and other expenditures will be for similar sets of products). In short, demand for EI from project sources is entering an exceptionally important phase in Thailand

- o the government is publicly committed to a programme of industrial restructuring for which it has received financial backing and in which an institutional apparatus has been created and is functioning

3. Taken together, these conditions add up to a context of both considerable opportunities and considerable risks. The government must decide whether it wants to take an active role or not in a reorganization process that has already begun and is bound to become much more pronounced in the next few years. If the decision is in the affirmative, than the problems centre on the orientation of public sector demand and of private sector activity. Whatever the source of demand, two kinds of information are required as a basis for future policy. The first is of a factual nature: what are the reasons for preferring foreign produced EI goods and services, and what could be done to influence those preferences? So far there seem to have been few, if any, detailed analyses of this kind. Engineering associations would be in a good position to carry them out. By selecting a set of recent transactions, quantitatively important and in which there were known to be chances for domestic as well as foreign sowing, and interviewing the purchasers, a reasonable mapping of the obstacles to raising LC could be made. Without that empirical base, most policy endeavours would amount to little more than stabs in the dark. The second type of information concerns objectives: are there priorities for favouring particular areas of EI production? To answer that implicitly if not explicitly requires the government to adopt a strategic approach to EI. That would be along the lines of vertical integration of specific areas of production through an attempt of creating backward linkages, by trying to specialize in bits of EI where Thailand might have export possibilities, or through other means.

4. The empirical work referred to above would allow an estimate of the extent and nature of EI demand that could, if proper steps were taken, be satisfied from domestic rather than foreign sources. Through what mechanisms could such demand be captured in future projects? An important possibility to consider, and which has been used quite successfully in other DC, is the creation of domestic engineering consultancy enterprises. Their functions are well known: to work out the organization of engineering projects; to identify sources of supply for the various components of the project; to ensure that timetables and schedules are adhered to; and to assist in the negotiation of contracts with suppliers. Domestic involvement in this process can perhaps best be affected through some form of collaboration arrangements with foreign consultancy firms. The content of those arrangements will depend on the complexity of the projects, the degree of existing domestic engineering capabilities, and the overall government policy towards foreign collaboration. In the early stages, project tender documents can be drafted to ensure that only consultancy firms with a certain level (perhaps majority) of domestic equity participation and management involvement are permitted to bid for a project. This simple device encourages formation of joint ventures; a few additional requirements are usually enough to ensure that the joint venture is genuine and not merely a fictitious entity through which total foreign control is exercised.

5. It is quite probable that in Thailand such ventures would, at least to begin with, have the foreign firms or prime contractors with the domestic partners playing a secondary role, perhaps focussed more on plant construction. Over time, however, as the experience of other DC (e.g. India, Republic of Korea, Brazil) has shown, it is possible for domestic engineering to acquire a stronger role, both through taking over prime contractor responsibility and via a conscious effort to upgrade local suppliers. The latter condition will be fulfilled only if the consultancy engineering firm uses the purchasing power delegated to it by the investors as the incentive with which to lead domestic suppliers towards improving their work. That task cannot be accomplished unless the demand is continuous and rigorous maintenance of standards is ensured. It is worth considering whether public capital involvement in at least one or two joint ventures might not be the best way of handling those conditions.

6. The essence of the effort of developing engineering consultancy, then, is to use that as a bridge to orient demand towards the better sources of domestic supply - localization of services is taken as an investment through which to raise LC. This approach is project oriented and is of less direct use for EI products where demand is not related to fresh investments. Hence the process of 'image creation' for domestic suppliers is not so easy to concretize through setting up new institutions. What may be worth considering, however, is the feasibility of establishing trading houses devoted to EI. They may, provided they are adequately staffed and have sufficient financial strength, be able to channel demand towards local suppliers.

7. This note has not touched on the crucial issues of government procurement or of the export market: these are the subject of separate notes to the seminar.