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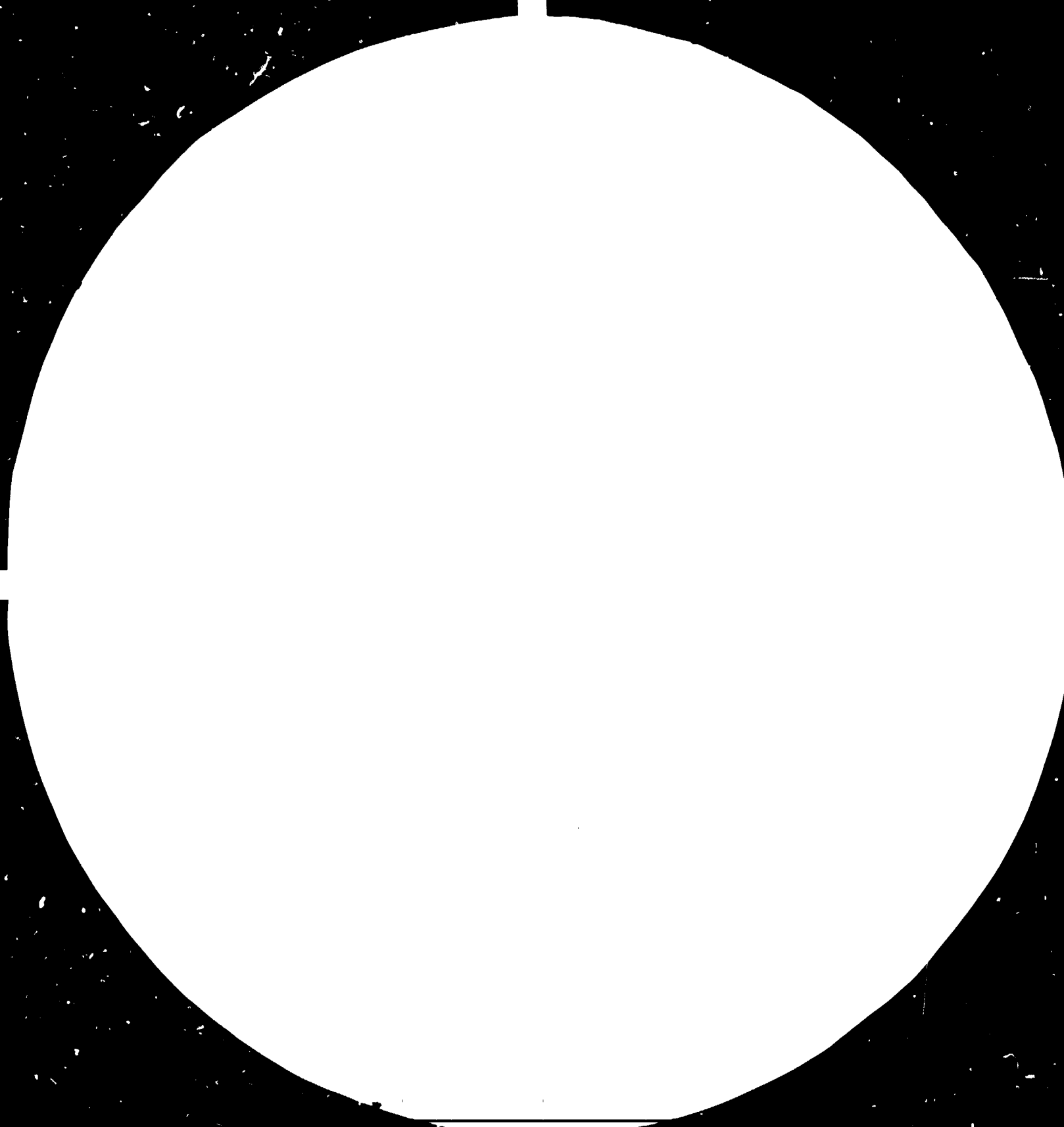

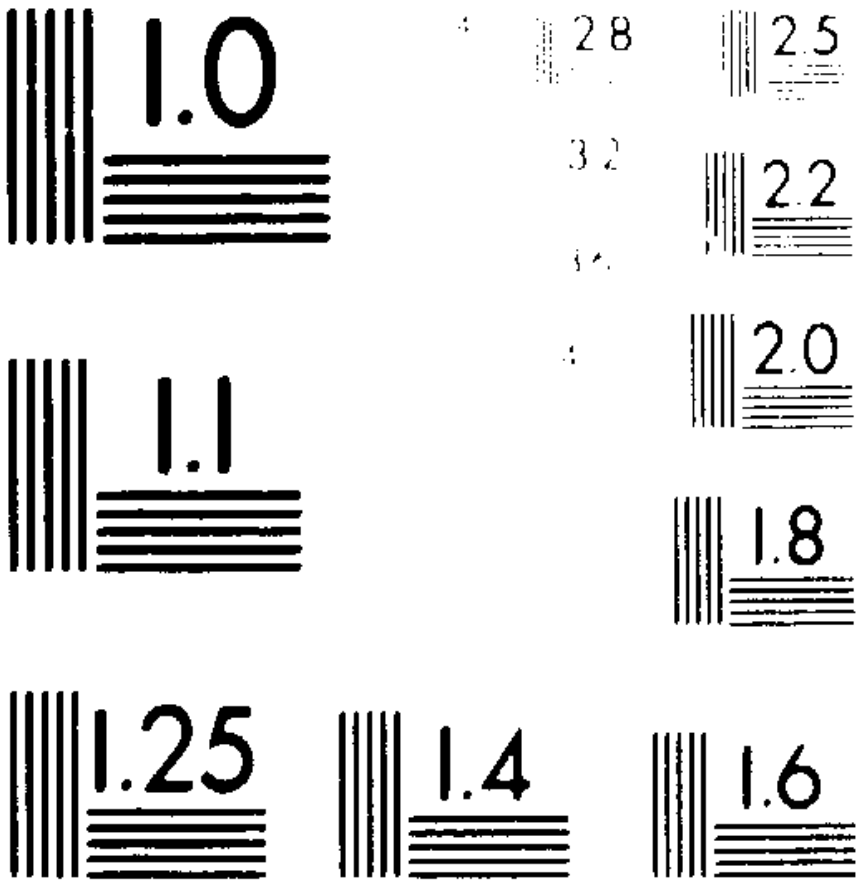

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ENGINEERING INDUSTRIES IN THAILAND *

Seminar on industrial restructuring by the RESCOM Secretariat and UNIDO
5-6 November 1984*

Prepared by the
Regional and Country Studies Branch
Division for Industrial Studies

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EXECUTIVE SUMMARY

The Seminar on Engineering Industries in Thailand was held in Bangkok 5-6 November 1984, organized by the Secretariat of Thailand's Industrial Restructuring Committee (RESCOM) in co-operation with UNIDO. The Seminar brought together high-level Thai officials and policy-makers, representatives of the engineering industry, and international experts with the prime objectives to jointly identify the key issues connected with restructuring of the engineering industry within the framework of Thailand's overall industrial restructuring programme. The Seminar also aimed at ascertaining the views of the business community on the prospects for development and to plan continued work towards structural changes and growth in the engineering industry sector.

After a review of the current situation in the engineering industries in Thailand in relation to recent international trends, the Seminar devoted attention to the role of the country's small-scale industry (SSI) in the various segments of the engineering sector. The output of the engineering industries can be classified into end products and intermediate products, components and parts. In the industrialized countries the SSIs are concentrated in the production of intermediate products. In Thailand as in many other developing countries, however, considerable number of SSIs manufacture end products. Indeed, specialization of production, and concentration on particular engineering activities, subcontracting and complementation are much less common features in developing countries.

In the engineering sector, internationally, it had during the last two decades been introduced significant changes in production technology. The application of numerical control of machine tools, for instance, enabled mass production of machine products. The automotion in plant operations around the production process, made it possible to automate quality inspection. The introduction of multifunctional machining centres with automatic changes of tools and three-dimensional working capacity enabled reshifting in machining operations.

After several years of development and testing, computer-aided design (CAD) and computer-aided manufacturing (CAM) are now being used on a large scale. These two systems are of increasing importance for the competitiveness of individual plants. Also the SSIs in the engineering sector will be affected by this technology in so far as it will, firstly, require that the SSI entrepreneur is able to respond in his production to the changing production environment; and secondly, represent additional business opportunities for SSIs, yet of a different type than what is commonly known up to now. The spread of new technology also to parts of the SSI sector will result in the emergence of two distinct types of SSIs:

(i) The traditional, labour-intensive enterprise manufacturing relatively low priced products of low technological complexity and low quality standards;

(ii) The modern, more capital-intensive technologically advanced and flexibly operating enterprise using machine centres and CAD services, applying CAM for manufacturing products of international quality standards.

Besides the supply side of the industry, i.e. technology development and product development and quality upgrading as well as financing, the Seminar dealt with demand-related issues, such as questions related to increased utilization and transparency of the domestic market for engineering products, to Government procurement policy, and to a strategy for developing versatile manufactured exports in the field of engineering products.

The Seminar was concluded with review and discussion on the long-term perspectives for Thailand's engineering industry and required policy measures. Present policy directions for the forthcoming 6th Plan - and for the remaining half of the 5th Plan period - identify three major groups of priority industries, namely:

(1) Export oriented industries;

(2) Small and rural industries or industries located in areas outside Bangkok and its surrounding area;

(3) "Leading" sectors:
(i) engineering industry
(ii) agro-based industry.

Besides being designated as one of the two 'leading' sectors, the engineering industry forms an important part also of the Government policy in respect of the two other priority groups.

The development of the engineering sector would need to be based on a broad strategy and supported by a set of specific policy measures. The strategy would need to define, inter alia, the prospective roles of the different segments of the sector such as (i) the traditional engineering industry sector and the modern sector moving towards high technology; (ii) the large- and small-scale industry and (iii) the predominantly domestic-oriented and the internationally-oriented parts of the industry. Policy for the promotion of the particular parts of the sector would have to be identified, such as measures towards the creation of expanded local demand, Government procurement, promotion of technology, provision of financial support, and export supporting measures.

The diversity of engineering industry both in terms of the range of products produced and processes employed as well as the breadth and resilience of the enterprises involved, compels the Government to acquire a considerable knowledge of the sector when conceiving policy measures. The effective development of engineering industries requires also evolving efficient mechanisms for government/enterprises co-operation.

During the concluding session of the Seminar elements for a proposed programme of action for the engineering industry were elaborated. These covered seven groups of measures: (i) sector information, (2) promotion, (3) high technology production, (4) standards, (5) Government procurement, (6) engineering services and (7) public information.

1. Sector information , market intelligence

The importance of systematically acquiring up-to-date knowledge of the sector was seen as one of the key prerequisites for any ambitious programme for the enhancement of the engineering industry. Efforts need to be made by both the national policy-makers and industry itself to build up such surveillance. This would encompass collection and dissemination of information in areas such as:

(a) Current and prospective trends and structures of domestic demand. A particular dimension of this demand would be the public sector. Another important aspect is the potential for increased sub-contracting and intra-industry integration.

(b) Domestic capabilities of production of key product groups both in terms of standardized goods and 'tailor-made' goods and components.

(c) Export potentials. The assessment and utilization of export markets would necessitate new efforts in international marketing, including segmented marketing in the ASEAN group, Asian region, other developing countries and developed countries.

(d) Trends in technology development. This would require continuous surveillance of development in areas of importance for Thailand.

2. Promotional measures

The promotional requirements cover approaches for the two broad categories of the country's engineering industries - the traditional, mainly labour-intensive manufacturing enterprises and the modern technologically advanced enterprises. Although some industries would fall between these two categories, e.g. a few quite skill-intensive medium-sized enterprises the supporting measures could be conceived along these two basic approaches.

As to the traditional, mainly labour-intensive manufacturing enterprises, attention should be concentrated on the following supporting or promotional programmes:

(a) Assistance or extension services in general areas such as:

- production technology (plant layout, use of tools and fixtures, etc.)

- financial planning (including formulation of loan applications and strenthening of self-financing through reallocation of resource within the enterprises)

- accounting, cost calculation and sales price fixing;

(b) Provision of suitable credit facilities, schemes of leasing machines and equipment;

(c) Promotion of subcontracting and complementation;

(d) Special technical services; measures facilitating access to, and application of, new relevant technology;

(e) Measures for enhancing product standards and quality control;

(f) Support to the creation of industry associations and joint marketing efforts, (e.g. fairs, preparation of buyer's guides);

(g) Training courses for upgrading skills in both commercial and technical fields.

As to the modern technologically advanced and flexibly operating enterprises another set of promotional measures would be envisaged. These enterprises would increasingly use machine centres and CAD services, apply CAM and manufacture products of international quality standards. For this group of industries emphasis would need to be laid on the following special programmes:

(a) Creation of a business environment (through fiscal and other incentives and promotional measures) conducive to stimulating expansion and adjustments;

(b) Human resources development (high level skills in informatics and engineering);

(c) Investment in technology (R and D facilities, capacities for adaptation of technologies, etc.);

(d) Provision of credit and government guarantee facilities;

(e) Information on technological advancement of the machine industry, computer industry and software developments;

(f) Pilot (high technology) machining unit with CAD/CAM facilities to demonstrate the benefits and potentials of and capabilities to use high technology.1/

1/ Pilot machining unit with CAD/CAM facilities:
- 2 computer controlled machining centres with 40 station tool-changers
- 2 computer controlled general purpose bar/chucking lathes
- 1 CAD/CAM system for processing from design to manufacture.

3. Selection of strategic products suitable for the modern high technology engineering industries

In order to provide the necessary framework for the elaboration of policies and measures for the engineering industry as a leading sector, broad product groups would need to be identified which would seem to have particular prospects for the high technology industries in Thailand. On the basis of an assessment of potential backward and forward linkages with products requiring similar materials, processes, manufacturing and technology, the following categories of products were tentatively identified:

(a) Set of parts and components as example for flexible machining (e.g. gears, shafts, casings, couplings);

(b) Set of products as examples for flexible machining (e.g. engines, machine tools, pumps, generators up to 20 kW);

(c) Communication and electronics equipment;

(d) Design and manufacture of tooling (which would lend itself for development within the existing small-scale industries sector):

- metal cutting
- dies
- moulds
- chucks
- jigs and fixtures;

(e) Special machinery, such as:
- wood working machinery.
- certain types of textile machinery
- farm machinery, farm tools.

The Seminar found it important to stress that the concept of the engineering industry as 'leading' sector should essentially include capital goods and the intermediate products used for their production. This implies that the 'sector' would not be seen to cover the materials industry (iron and steel, etc.) or downstream products like consumer electronics industries (which would constitute a sector on their own with appropriate policies in support).

4. Standards and quality certification measures

Particular attention needs to be given to effective e..pansion of testing facilities. It was suggested that Thai manufacturers - in particular the small industry - would better benefit from the Thai standards books as means of technical promotion if these books were to include some guidance on how to achieve the set standards (as was the case in some developed countries, e.g. U.K. and Japan).

5. Measures related to Government procurement

A set of measures could be conceived for Government procurement to be more systematically used as a means for promoting local demand for certain engineering products. With financial support from a bilateral aid source, the Association of Thai Industries had been commissioned to undertake a detailed study on this matter.

Some possible measures were identified:

(a) Investigation of the potential of Government purchasing for the promotion of engineering industry;

(b) Assessment of the capability of local industry to produce the required products with the specifications set;

(c) Elaboration and provision by Government agencies and public sector industry of information of the next 5 years' requirements of key product groups, including their specifications;

(f) Activating industry's own informative and marketing efforts towards Government purchasing;

(e) Intensive testing programmes for locally produced items to demonstrate product aptitude and fulfilment of quality requirements.

6. Creation of domestic engineering services

The importance for the growth of the domestic engineering industry of developing domestic engineering services was emphasized. Engineering services would be able to increase the demand for domestic engineering industry products through planning and supervising the installation of processing plants, and by providing the necessary feedback for the industry. The domestic engineering services could thus be instrumental in

- the organization of engineering projects;
- identifying supply sources for the material inputs to the project;
- assisting in negotiations in contracts with suppliers.

It was suggested that in order to stimulate the growth of domestic consultancy and engineering services the concept of local content in terms of services might be applied. Guidelines might be established to ensure participation of Thai firms in consortia for large projects.

7. Public information

Programmes should be developed for the effective use of various means of communication (press, radio, TV) to better inform the Thai manufacturers on high technology and the role and capacities of the Thai engineering industry and to provide pertinent information on the key technology advances being made.

In concluding the Seminar Dr. Narongchai Akrasanee, stressed the high priority accorded by the Government to the engineering industry. The Industrial Restructuring Committee (RESCOM) was the forum for taking up the various proposals made for developing the sector, such as those related to the standards and testing system, the R and D and the technology promotion scheme as well as financial issues. It was in this context that the Seminar and its timing were of particular significance. He also noted that the RESCOM would soon initiate work on the preparations for the next Development Plan, in which the engineering industries are expected to be designated as a 'leading' sector. The findings of the Seminar could form an important basis for the sector development plan. The Seminar thus marked the beginning of a period of intensified attention and work relating to this particular sector.

I. INTRODUCTION

Background

The Fifth National Economic and Social Development Plan of Thailand, 1982-1986, identified industrial manufacturing as a high priority for the country's economic development. Increased attention would be given to enhance industrial development within overall economic growth by better utilizing the industrial potentials and re-assessing the pattern of industrial development.

A lack of built-in flexibility to meet emerging challenges and overall economic goals prompted the Government to inititate a systematic review of the pattern of industrial development. A programme of industrial restructuring was initiated and is being implemented during the plan period.

The responsibility for the management of the industrial restructuring programme, rests with the inter-ministerial Industrial Restructuring Committee (RESCOM), and the National Economic and Social Development Board (NESDB), as secretariat of RESCOM, has been entrusted with the task of providing technical and analytical support to the programme.

In late 1982, UNIDO entered into close research collaboration with RESCOM and NESDB. A number of exploratory and advisory missions were undertaken with the purpose of providing assistance to RESCOM and its secretariat in carrying out the programme. During 1983, the RESCOM secretariat completed studies on various subjects.

The work undertaken by RESCOM and the findings and recommendations by the UNIDO missions during 1982/83 were reviewed at a Seminar on Industrial Restructuring held 22-23 October 1983 at Pattaya, Thailand, organized by RESCOM and UNIDO. The seminar addressed the various issues of the restructuring programme, and ascertained views of the business community on the past and continued work on structural changes and growth in the manufacturing sector. A detailed report on the Seminar has been prepared.[1/]

1/ UNIDO/IS/R.13.

Particular attention at the Pattaya Seminar was paid to the need for industrial restructuring in the Thai electrical and electronics industry[1/] and for technical assistance to the engineering indutries.[2/] The central position of engineering industry in economic and industrial development was emphasized and active pursuance of the comprehensive engineering industry sector programme developed by RESCOM was suggested. In this connexion the need for further detailed studies of the engineering industry and the development of incentives packages, e.g. for technclogical development, was underlined. In order to give due prominence to this important subsector it was suggested that Thai engineering industry - production capabilities, problems, bottlenecks, etc. - be discussed at a special seminar to be organized in 1984.

This Seminar on Engineering Industries in Thailand - the subject of this report - was held on 5 and 6 November 1984 at the Hyatt Plaza Hotel in Bangkok organized by the RESCOM Secretariat and UNIDO. The Seminar brought together high-level Thai officials and policy-makers and representatives of various parts of the engineering industry, with international experts and UNIDO staff,[3/] with the objectives to assess the various issues of the restructuring programme in the engineering industry field within the framework of Thailand's industrial restructuring programme as a whole; to get response from the point of view of the business community; and to lay the ground for continued joint work towards structural changes and growth in the engineering industry sector.

To this end, the participants were to analyze the pertinent domestic and international prospects and challenges for Thai engineering industry in the 1980s and examine the sets of possible policies and measures at micro and macro levels conducive to the industrial restructuring required. In particular the Seminar aimed at:

1/ Industrial restructuring and the electrical and electronics industry, by Narongchai Akrasanee (Seminar paper No.2).

2/ Technical assistance for engineering industries, by Chatri Sripaipan (and others) (Seminar paper No.6). See also Annex 11 (Summary of proposed programme of engineering industries development) of UNIDO/IS/R.13.

3/ The list of participants at the Seminar is appended as Annex 1.

(i) reviewing the work so far undertaken by the RESCOM on the engineering sector, i.e. the analyses of the present stage of development and future prospects for the Thai iron and steel and non-ferrous industry and machinery industry as well as the detailed recommendations relating to technology development and promotion for the engineering industries;

(ii) exchanging views on the findings and results of the above work;

(iii) highlighting key issues for future developments of this subsector in terms of, inter alia, technology, skills, material inputs, markets, company structures and international relations; and

(iv) enlisting comments and suggestions for RESCOM's future programme and for programmes by the industry itself.

The programme for the Seminar is appended to this report as Annex 2. A set of documents or background papers covering a number of issues was prepared in advance of the Seminar and presented in relation to the various items discussed. These papers are listed in Annex 3.

II. OPENING OF THE SEMINAR ON ENGINEERING INDUSTRIES IN THAILAND

The Seminar was opened by Dr. Praphas Chakkaphak, Permanent Secretary, Ministry of Industry who in his opening address stressed the central role of the engineering industry sector in Thailand's industrialization and noted that in the context of the industrial restructuring comprehensive programmes were being developed with the parties concerned. Some of the promotion schemes for the sector's further development were starting now while others were still being worked on. It was therefore of great importance that this Seminar on Engineering Industries in Thailand was being held at this time. It would be expected that it would contribute a great deal towards the understanding of the engineering industries and the country's plans and programmes to further develop them.

Dr. Narongchai Akrasanee in an introductory statement noted that the Seminar was part of the co-operative work between the Government of Thailand and UNIDO/UNDP in the field of industrial restructuring. A series of studies were carried out during 1983 and 1984 together with NESDB and Ministry of Industry for the use of the Industrial Restructuring Committee; in 1984 particular attention was being given to the engineering industry development.

The papers to be presented at the Seminar, some of them had been prepared by experts from Thailand and others by UNIDO experts, were to reflect the previous study work in the light of recent international trends and development patterns in the engineering industry field. Thus, the purpose of the Seminar was to bring together a number of Thai experts and UNIDO experts interested in engineering industry to exchange views on various studies and issue papers prepared on the Thai side as well as by the UNIDO group. It was envisaged that the outcome of the Seminar would be presented to the Industrial Restructuring Committee for further decisions and implementation. Recommendations from the Seminar would also be followed up on by the various Government agencies concerned with the development of the engineering industries.

III. CURRENT STATE OF THE ENGINEERING INDUSTRIES

The first session of the Seminar dealt with the development, in general terms, of the engineering industries sector in Thailand and internationally. Four papers were presented.

(i) Engineering industries in Thailand: An overview

Dr. Chatri Sripaipan, Associate Professor, Faculty of Engineering, Chulalongkorn University presented a paper "Engineering industries in Thailand: An overview".[1/] He noted that the Thai economy was now going through the initial phase of a longer term approach to industrial reorganization, and that there had been a growing interest on the part of the Government and of the donor community in promoting the Thai engineering industries. There were some common characteristics of the engineering industries which were important in this context:

- First, many engineering products can be produced reasonably efficiently at a small scale of output;
- Second, the engineering production units tend to be labour-intensive, and offer opportunities for absorbtions of labour. But they also tend to be skill-intensive which, if properly developed, would create a pool of skilled labour;
- Third, there are some products - mostly parts, components - for which export markets exist. Subcontracting of parts can be a significant element;
- Fourth, there are strong linkages both backward and forward among products. Products usually require the joint utilization of several processes (e.g. forging or precision casting followed by machining and heat treatment; in other words a given product serves as link for various processes). Processing facilities are highly versatile and can turn out a great variety of products. Engineering products are used extensively as inputs in the production of other engineering products;
- Fifth, the engineering industries tend to be the "carriers" of technological change. Because of the heterogenous nature of the products, constant adaptation of the products usually occurs, and there are numerous opportunities to borrow ideas and to make changes that have effects beyond the confines of the engineering industries themselves.

1/ Issued by IMC as Paper No.1 prepared for the Seminar on Engineering Industries in Thailand, Bangkok, 5-6 November 1984.

Dr. Chatri's paper suggested that Thailand may have considerable scope for the development of engineering industries based on an increasing internal demand. At present this demand is largely filled by imports and it had been suggested in previous studies[1/] that the technical and economic capabilities were deficient. Competition with imports was impaired by a lack of knowledge on how to utilize existing resources of machine and labour efficiency and by the lack of a programme to improve their technological capabilities. Barriers or obstacles to modernization and development of those industries resulted in high cost, degraded product quality and a general inability to react flexibly as required in a competitive market. There were many causes underlying this situation, such as:

- lack of basic knowledge of engineering techniques;
- relatively low level of production technology capability (e.g. lack of capability to produce products of even quality);
- Unavailability of industrial supplies and materials and/or limited knowledge in selecting and use of materials and equipment;
- insufficient supply of skilled labour in appropriate field;
- inadequate design and innovative skills to initiate new products or adapt foreign designed products to suit the requirement of the domestic market;
- inability to obtain relevant information in production technology, markets, raw material supplies, and equipment usage;
- bias in the fiscal system of protection and multiple taxation which works against domestic production of engineering goods; and
- small market, irregular orders and severe competition.

It was noted that engineering industries in Thailand basically were of two kinds; firstly, small Thai-owned enterprises which generally concentrate on the production of machinery and parts mainly for agricultural processing and in repair works, pocessing little or insignificant technological know-how; and, secondly, larger engineering industries, either completely Thai-owned or joint ventures, which have developed in response to Government policies to encourage import substitution of various kinds. Dr. Chatri

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1/ World Bank, "Development of Engineering Industries in Thailand", 17 May 1980. Research and Data Resources Co. Ltd, "The Feasibility of a Project to Develop Engineering Industries in Thailand", June 1981.

suggested that small and medium firms were considered to have the most potential for future development but that they suffered disadvantages vis-à-vis larger firms in terms of access to know-how and technology to significantly improve the quality of their products at reasonable cost. The larger firms were in much better position, themselves already having considerable expertise and wider access to sources of technology.

Although it might be considered that the awareness of new or appropriate technology for industrial products and production techniques should primarily be the responsibility of the industry itself, understanding and practical support by governmental bodies were needed for, in particular, small and medium scale industries.

(ii) Recent international trends in engineering industries and issues for consideration in Thailand

A second paper, prepared by the Regional and Country Studies Branch, UNIDO, dealt with "Recent international trends in engineering industries and issues for consideration in Thailand".[1/] It was, first of all, noted that the engineering industry is a leading sector in the context of economic development, generally with an expanding rate of growth relative to the economy as a whole and as part of the exports. Of total world output of engineering industries products the developing countries accounted (in 1980) for roughly 6 per cent, while the developing countries' exports of engineering industry products was less than 3 per cent of the global figure. Table 1 shows the weight of major engineering industry product groups in production and exports in some Asian countries. By comparison the equivalent production share in USA in 1981 was 33 per cent and the range for other main OECD countries 30-40 per cent. The 1991 production target share for the Republic of Korea is 38 per cent of MVA in engineering industries.

While the above figures may illustrate the overall magnitude of the engineering industry, current and potential, the heterogenity of the engineering industry sector renders generalities about its production

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1/ The full text of the paper is appended as Annex 4.

structure - between the ISIC categories metal products, non-electrical machinery, electrical machinery and transport equipment - hazardous.

Table 1. Machinery and transport equipment, share in production and export in selected Asian countries, 1981

	Production (% of total MVA)	Exports (% of total MVA)
Thailand	15	5
Indonesia	7	1
Malaysia	18	12
Philippines	10	3
Republic of Korea	18	22
Singapore	55	22

The engineering industry sector is a vehicle for technology; it generates technology; it requires technology. As was pointed out by Dr. Chatri in the preceding presentation, engineering industries is a focal area for the introduction of new technologies, such as numerically controlled machine tools (NCMT), computer aided design/computer aided manufacturing (CAD/CAM). The structure of engineering industries would seem to be an important factor in this connexion. Investigations have been carried out aimed at assessing the type of products, for which new technologies are used. The products were divided in four categories:

- consumer goods (e.g. bicycles, automobiles, radios)
- investment goods (trucks, various kinds of machinery)
- components (e.g. ball bearings, electric motors, pumps)
- goods consumed in the production process itself (e.g. cutting tools).

The findings were that in particular components and consumption goods were highly susceptible to quick introduction of the new technologies (both components and consumption goods are, in most cases, items characterized by large production volumes and relatively standardized). Since in both categories the new technologies are applied to key elements of production processes, the implication is that the ways of manufacturing these items are now altering dramatically. These innovations tend to reduce both capital and labour intensities of production. They could at the same time potentially bring substantial benefits to developing country producers. To realize that

potential, radical changes in organization and training would be required. It needed in this context to be emphasized that:

- the engineering industries are a prime activity for the absorbtion of foreign technologies into industry at large and can serve as important stimulant for the development of domestic technological advances;

- the engineering industries provide base points for the introduciton of new technologies, embrasing 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 tranformation via microelectronics);

- the engineering industries can provide training ground for generating general industrial skills;

- the engineering industry sector is the pivot of sub-contracting systems and thus inter-industry linkages;

- the engineering industries is composed of a wide variety of enterprises from very large multifaceted enterprises to small workshops, all operating under the same broad umbrella but perhaps with the last group not coming effectively within the sphere of government policy actions;

- there is a significant demand for engineering products and services from large investment projects, i.e. ad hoc activities which often impose heavy requirements on local supply.

Experience gained in a number of Asian and Latin American countries in the development of domestic engineering industry capabilities, permitted identification of a few problem areas confronting Governments when designing policies:

- The diversity of engineering industries, both in terms of the range of products produced and processes employed as well as the breath and resilience of the enterprises involved, compels a government to acquire a considerable knowledge of the sector before policy measures are launched;

- A conscious strategy for incorporating engineering knowledge is the only way through which local firms can strengthen their capabilities. Some developing countries, e.g. in Latin America, 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 specific items) and on the other hand 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. The pattern of demand for important segments of engineering products suggests that credit policy be established to help firms to overcome uneven flows of orders. Attempts to win international contracts for supplying engineering products can usually not succeed unless the local enterprise can offer supplier credits. The provision of government financial guarantees may play a vital role here;

- Since the enhancement of domestic skills can hardly be accomplished without foreign collaboration, various governments in developing countries have found it necessary to focus on ways of organizing that collaboration, e.g. through joint ventures in the area of project engineering;

- Attention should be given to conditions set in the provision of loans (e.g. by international financial agencies) for big projects. These conditions may often have a limiting influence on the possibilities for local engineering participation;

- In certain areas of engineering industry, particularly fabricated metal products, component manufacture in the transports 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. Success in penetrating the international markets to supply such equipment items requires the meeting of high quality standards and well developed quality control systems.

Against these features of the engineering industry the prospects and constraints of this industry in Asia and in particular in Thailand were briefly touched upon. It was noted that there persists major structural constraints which are pertinent for the discussion in the Seminar:

- The concentration on particular engineering sub-sectors, such as electronics components which make heavy use of unskilled labour, and have few domestic linkages (which may be partly explained by the fact that they are linked with foreign firms).

- The very limited capabilities to supply equipment to large industrial projects.

- The fact that activities in export-oriented, unskilled labour-intensive areas of engineering dominate, suggests that countries in the region may be particularly vulnerable to the consequences of technological changes now occurring on a major scale. The main OECD countries are proceeding rapidly towards major reorganization of their production systems. The principal consequences for the southeast Asian countries may be that they would have to look more towards the domestic markets and options (including regional co-operation) at the same time as launching major efforts to advance quickly in selected areas. In other words, they would have to make considerable efforts to catch up with technology in selected areas for exports coupled with up grading of the domestic engineering production, particularly machinery production.

- Prevailing deficiencies in engineering design capability would be a major issue if the industry was to be restructured along above lines.

The key issues, as identified in the UNIDO paper, would seem to revolve around two major considerations. First, there would be a need to develop mechanisms of encouraging firms to move into different technological spheres. Second, the increasing requirements of technical knowledge from the side of the Government and from industry itself regarding changes and trends in engineering production on the international scene. If the countries in the region, in pursuance of their economic policies will continue to link closely with the international market, this would by necessity compel them to keep up-to-date in at least some engineering areas. To accomplish that, effective mechanisms of Government/enterprises co-operation will be of great importance.

(iii) Current state of the metal and metal products industries in Thailand

Dr. Rachain Chinthayarungsan, Lecturer, School of Development Economies, National Institute of Development Administration (NIDA), presented a paper "Current state of the metal and metal products industries"[1/] which provided an overview of the current research work by the RESCOM secretariat in that field. At this stage their efforts were concentrating on investigating the general characteristics of the industry in order to identify specific areas for more detailed investigation in respect of each particular sub-sector. The paper covered the following aspects:

- The role of the metal and metal products industries in the national economic structure, including linkages among sectors in the metal, metal product and machinery industries (see Figure 1). Production and trade in metals and metal products in Thailand is shown in Table 3.

- Growth performance. Between 1978 and 1982 production of metal and metal products increased by about 25 per cent in value terms (current prices) which is much lower than the 83 per cent growth of the GDP during the same period. Thus the growth performance of the metal and metal product industries was quite unsatisfactory. The domestic demand expansion was not well utilized by local producers. While the stagnation of tin exports was the main reason for slow overall expansion in exports, the export performance of the rest of the

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1/ Issued by IMC as Paper No.2 prepared for the Seminar on Engineering Industries in Thailand, Bangkok, 5-6 November 1984.

Figure 1. Direct linkages among sectors in the metal, metal product and machinery industries

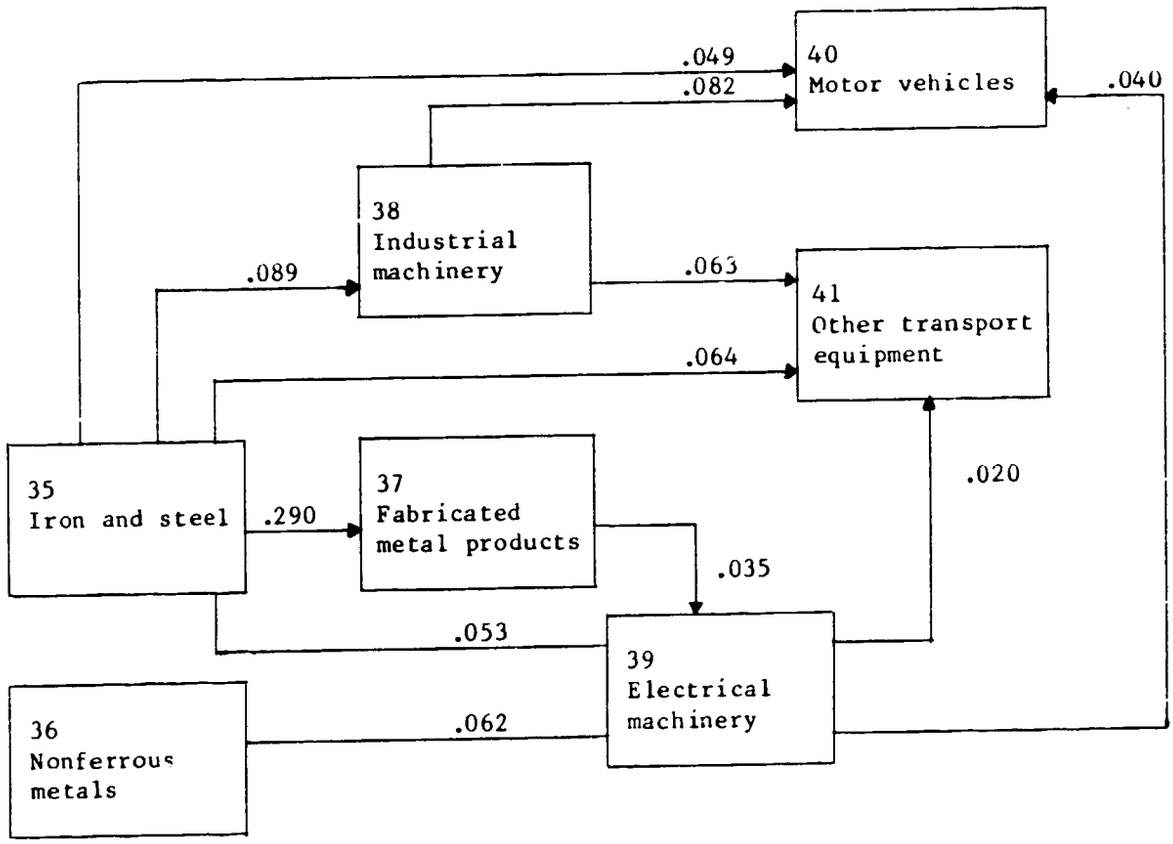

Table 2. Thailand: Production and trade pattern in metals and metal products, 1982
(in million Baht)

Sector		Production	Export	Import
105	Iron and steel)	10,207	183	1,965
016	Secondary steel products)			
107	Nonferrous metal	14,189	7,995	4,107
108	Cutlery and hand tools	3,571	195	937
109	Metal furniture and figures	1,474	373	35
110	Structural metal proudcts	1,843	217	85
111	Other fabricated metal products	2,131	667	2,235
	Total	33,415	10,146	21,022

Sources: NESDB, Foreign Trade Statstics of Thailand.

industries was, however, quite respectable and, contributed significantly to the (although limited) overall growth of the sector.

- Industry structure. Although the metal and metal product industries consist of highly heterogenous types of products, a large number of these products are subject to common processes so that competition is keen among firms which can easily switch from producing one product to another. More than 80 per cent of the firms are small scale (with less than 20 workers.) The most common types of those firms are machine shops and those engaged in production of doors and window frames. Large firms tend to concentrate in the secondary steel products which require modern facilities and heavy equipment, such as construction steel, tin plate, galvanized sheet, tube and pipe.

- Technical problems in the metal and metal products industries.

  (a) Most of the foundry work work are small scale operations mostly using rather obsolete technology, and the quality of casting is generally low. However, there is a second group of larger establishments with fairly modern facilities enabling production of most standard alloy steel castings. There are problems of shortage of qualified pattern makers who can work from drawings.

  (b) Press work. The presses produce parts with satisfactory quality only for products which do not require close tolerance. They have a rather high scrap rate.

  (c) Fabrication. Large fabrication firms are fairly well equipped with various types of equipment including automatic welding equipment. Testing facilities are also available in larger firms which include ultrasonic and x-ray devices. For small fabrication shops, only simple electric and gas welding equipment are used. Light fabrication industry, such as metal furniture industry employs relatively simple processes. Major problem is the product design capability. There is doubtless export potential for well-designed products.

  (d) Machining. The machinery capability is generally low. Some larger foundries, especially those producing machinery parts, operate their own machine shop.

(iv) Current state of the machinery industry in Thailand

Dr. Boonwa Thampitakkul, Assistant Professor, Faculty of Engineering, Chulalangkorn University, presented a paper "Current state of the machinery industry"[1/] covering the country's wide range of mechanical and electrical machinery industry, such as engines and turbines, agricultural machinery, wood

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1/ Issued by IMC as Paper No.3 prepared for the Seminar on Engineering Industries in Thailand, Bangkok, 5-6 November 1984.

and metal working machinery, special industrial machinery, office and household machinery and electrical industrial machinery.

Table 3. Thailand. Production and trade pattern in machinery industry, 1982

(in million Baht)

Sector		Production	Export	Import
112	Enginees and turbines	1,030	96	5,356
113	Agricultural machinery)		28	184
115	Special industrial machinery)	16,765	498	13,703
116	Office and household machinery and) appliances)		241	1,787
114	Wood and metal working machine	343	21	608
117	Electrical industrial machinery and appliances	1,428	28	1,380
	Total	19,566	912	23,017

Source: NESDB, Foreign Trade Statistics of Thailand.

In reviewing the machinery industry development in Thailand four major trends were observed in the sector's development since the early 1960's (when the Government through the Board of Investment began to play a major role in encouraging and regulating domestic and foreign investment):

(1) A number of workshops, having earlier required, and bought from outside, machinery of certain types, realized that they had the technical capabilities to produce such machinery themselves;

(2) Certain workshops undertook repair work in industries such as paper mills and sugar mills. The equipment was often bulky and some replacement parts could not be obtained readily due to obsolence. These shops later expanded their work to include the production of spare parts and a few produced and supplied complete machines to those sectors;

(3) Some trading firms found it profitable to manufacture the machinery they had previously been importing. Joint venture companies were set up to which the foreign partner generally supplied the technical know-how;

(4) Expansion of agro-industries resulted in factories which were often built on turn-key basis. The technology was normally brought in from abroad and the products are of international standard with the main technical knowledge gained in processing and control technology.

Among the four categories described above, the first two were those which have had the most difficulties to survive and prosper. Various support measures would be required specifically to assist these companies most of which had started as small workshops and whose owners/managers have limited formal technical training.

Dr. Boonwa then reviewed in some detail the technical state of the country's machinery industry - plant layout and working conditions, machine tools and machine shop practices, use of unskilled, semi-skilled and skilled workers, product quality, management systems etc., before, in concluding his presentation, he put forward some suggestions for Government action towards furthering the future development of the country's machinery industry. He noted that a large number of the industries set up during the last decade or so has primarily been concerned with assembly. This type of industry requires a very small number of skilled or semi-skilled workers but latter requires a great number of unskilled labour. At the same time, the country has during, say, the last 20 years, got a large number of persons trained in vocational schools who could be classified as semi-skilled workers or technicians. For sure, some of these now run their own engineering industrial works, but the majority, without the opportunity and capability to start their own business, have found the country's engineering industry sector too small to absorb their number. In this situation the current development plan has rightly put more emphasis on manufacturing industries which are expected to demand more skilled labour.

Specifically, owing to the difficulty in reshaping the whole mass of the engineering industries in the country which, if possible at all, would require very much time and resources, it was suggested that the setting up of specialized units with highly competent personnel in the area of production technology should be promoted. Indigenous technical know-how obtained in these units could be utilized especially by the larger machinery manufacturers - categories (3) and (4) above - which at present had to rely totally on foreign sources. High technology 'fall out' could, moreover, be readily available to the factories of categories (1) and (2).

(v) Discussion

In the discussion following the four presentations Dr. Narongchai referred in particular to the characteristics of the engineering industry sector of very strong linkages with other industrial sectors and of high import dependence and that the sector, in general sense, was relatively underdeveloped in Thailand having many technical problems.

Mr. M.A. Siddiqui, UNIDO, also draw attention to the various technical problems mentioned in the papers presented by Dr. Rachain and Dr. Boonwa. The problems facing the metals and metal products and the machinery industries were similar:

- lack of design and drawing capability;
- shortage of skilled workers particularly in the foundry industry;
- need for quality improvement;
- deficiencies in standardization testing and calibration.

He also suggested that attention be given to the question of to what extent the existing institutions in the country were providing various services required (e.g. testing services) and, if these services were not sufficient, to what extent could the capabilities of existing institutions like TISTR and TISI be expanded to meet such needs. He mentioned, as one example from another ASEAN country, SIRIM (the Standards and Industrial Research Institute of Malaysia in Kuala Lumpur) which, besides its tasks in the standards and research fields, was also providing industrial consultancy services catering, inter alia, for the problems of small and medium scale metal producing and metal repairing enterprises.

Mr. Chaiwai Sangruji, Secretary-General of TISI mentioned that the main tasks of TISI was the preparation and issuance of standards and the provision of certification service. It was thought that the work of TISI within the framework of available resources was quite satisfactory on the standards side although they would like to be able to give more attention to requirements of the engineering industry and would welcome any suggestions by the Seminar in that connexion. On the certification side, however, they were facing major problems due to the fact that TISI (in contrast to standards institutions in many other countries) did not have testing facilities of their own. They were

obliged to use the (surplus) capacity of existing laboratories in other institutions - e.g. Department of Science, TISTR, Textile Division of DIP - in all about 20 different laboratories. This situation frequently caused very substantial delays for TISI's responses to certification requests. As a measure to help alleviate this problem it had been suggested, through RESCOM, to encourage the setting up in the private sector of testing laboratories to be given required accreditation. This scheme was however still awaiting implementation.

Mr. Chaiwai also noted that the information (statistical and technical) available about Thailand's engineering industry - in particular the small-scale - was limited and somewhat out-dated. In the further discussion this matter was again taken up and the importance of keeping up-to-date, both from the Government side and within the industry itself, was stressed, in order to enable effective promotion of a dynamic domestic engineering sector in close relation to the international development.

Dr. Somchob Chaiyavej, Vice Rector, King Mongkut's Institute of Technology, felt that the paper presented by Dr. Boonwa on the machinery industry was very revealing of the situation in the industry, in particular the fact that the Government sector procurement was so little geared to use locally produced items. When Government departments or workshops presented tenders they were often specifying even brand names of (foreign) equipment. Always (according to Dr. Somchob) were the tenders won by foreign products, although, subsequently, it often became clear when the equipment was in use that Thai-made machines (with somewhat different specifications) would have fulfilled the requirements at about the same standard, and often at lower investment cost (depending upon whether 'soft' credits or other support measures had been involved). There were certainly also cases where the Thai machines may have rather slow speed compared with foreign makes, that the cutting should be improved, etc, but such upgrading could be done using the technological knowledge in the country, e.g. at the universities, in machining, jig fixtures and in the production process as a whole.

IV. SMALL INDUSTRY AND THE ENGINEERING SECTOR

At the second session of the Seminar, attention was given to small scale industry development in relation to the engineering industry. Two papers were presented.

(i) Electronics industry in ASEAN and the Republic of Korea - some issues

In the context of small industry development in the engineering sector a small note was presented dealing with the small scale electronics industry in some southeast and east Asian countries. The note had been prepared by the UNIDO consultant J. Raphael Chaponniere, Visiting Research Fellow at the Institute of Southeast Asian Studies (ISEAS) in Singapore, on basis of earlier survey work carried out by him.[1/]

Mr. Chaponniere, after having reviewed the development of the electronics industry in ASEAN countries and the Republic of Korea, noted that in a sense much of the initial setting up of that industry had been 'accidential', based on labour-intensive sub-contracting/assembly activities. These countries had now gained a foothold in this most dynamic industry which has now gained additional priority due to full recognition of its technological importance and desire to take advantage of the technological spin-off that electronics can offer. However, the new priority which is now given to electronics raises some issues, such as:

(i) Electronics industry is often a technological enclave; hoping for technical spin-off is perhaps a wishful thinking; and

(ii) without backward linkages export orientation is bound to give little value added.

As regards the first issue - technological enclave - Mr. Chaponniere noted that in most ASEAN countries the electronics industry consists of two, often unrelated, subsystems - one catering for the local market of consumer goods, the other engaged exclusively in the exports market. The former group comprises both local companies and joint ventures and includes several small scale industries and supporting industries. The latter usually comprises subordinaries of foreign firms.

1/ The full text of the note is appended as Annex 5.

In Singapore, for instance, the supporting industries have grown very rapidly during the last 10 years. These industries cater for the needs of firms wholly engaged in electronics, they produce plastics parts, engage in die casting of components and the production of precision mechanical parts. In 1981 these firms in Singapore employed 12,000 workers, 1/5 of the number of persons engaged by the electronics industry. The existence of these supporting industries is a significant incentive for foreign investors. Singapore, for instance, has now an edge on Hong Kong, the Republic of Korea and the Chinese Province of Taiwan in disc devices because the latter three, although strong in electronic components, are relatively weak in precision metal and mechanical parts and machining industry.

Indeed, electronics industry is not as 'industrializing' an industry as mechanical engineering. However, it is not unrelated with other industrial sectors. Having fulfilled the special needs of electronics firms, supporting industries can diversify their market. Also, a time comes when the electronics industry reaches a critical mass and a 'subculture' of companies can emerge serving the larger firms with components and other subcontracting.

As regards the second issue - export-orientation and backward linkages - Mr. Chaponniere noted that in several ASEAN countries export promotion is closely associated with export processing zones (EPZs) and export-oriented electronics industries. Exports consist of electronics components while domestic value added remains minimal. The experience from the Republic of Korea and Singapore indicates that another evolution can take place. Backward integration has been implemented by foreign firms in Singapore and one can speak of a "virtuous circle" to describe this evolution: Singapore has become one of the biggest exporters of radios and TV; this has attracted makers of parts, including components such as certain tubes with economies of scale requiring a production of over a million items per year. Also in microelectronics considerable backward integration has taken place. Upstream linkages are, however, not limited to production facilities; they also concern research and development.

In the Republic of Korea foreign firms do not play such an important role; backward integration is carried on by domestic private firms responding to the Government incentives, resulting from a strategy of "backward linkages import-substitution fuelled by export competitiveness".

(ii) The role of small industry in the engineering sector

A comprehensive note on small-scale industry in the engineering industry sector, entitled 'The role of small industry in the engineering sector', prepared by the UNIDO consultant Mr. Karl Heinz Plaetzer, was presented by the author.1/

Mr. Plaetzer, firstly, noted the definition of small industry varies from country to country. In Thailand two categories of enterprises are considered being a small industry: (1) small scale or cottage industries employing up to 10 persons and (2) small-scale industries (SSI) employing 11-50 persons. No other criteria are used. Many other countries use additional criteria to distinguish among the industrial sizes, such as investment per employee (often set at between US $1,000-3,000 in cottage industry or US $10,000 in SSI) or even total investment, being limited at, say, US $100,000 per enterprise. More important is the distinction, e.g. in many Latin American countries, between formal and informal SSIs. It has been shown in the recent recession in Latin America that the informal sector which consists of enterprises without legal registration has shown increasing employment figures while the overall employment figures of industry have declined. Various countries in Latin America have therefore started support programmes for these informal industries which aim especially at leading them towards a more formal situation.

(a) Some structural characteristics of small scale engineering industry

He also noted that the large dimension of the engineering industry, the great variety of products manufactured by it and the different structures of market outlets required differentiated approaches.

The engineering industry sector could be sub-divided into two major groups: capital goods and consumer durables. In general terms, production of consumer durables is technologically less complex and is for various reasons more advanced in developing countries than production of capital goods. The output of engineering industries could also be classified into end products

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1/ The full text of the note is appended as Annex 6.

and intermediate products, components and parts. In the industrialized countries the SSI concentrate on the production of intermediate products while in developing countries there is a considerable number of SSIs manufacturing end products. This would indicate that specialization of production, concentration of efforts on specific engineering tasks and subcontracting and complementation are in their early stages in the developing countries.

Also in the area of marketing there are marked differences between the SSIs in industrialized and in developing countries. Marketing is generally given much more attention by the entrepreneures in industrialized countries, especially sales promotion (catalogues, product descriptions) are much wider applied. The effort of the SSIs are often complemented by associations or by special governmental SSI development agencies. In some countries, e.g. USA, government procurement can require that the supplier subcontracts considerable portions of his contract volume to SSIs.

As a whole the sales market structure for engineering industry goods is less advanced in developing countries. Direct sales are predominant, subcontracting is little used and the markets are hardly transparent, neither the sales market for the supplier nor the supply market for the consumer. This is especially the case for parts and components.

(b) Effects of new technologies on the small scale engineering sector

Regarding technology in the engineering industry sector, Mr. Plaetzer noted that production characteristics have undergone considerable changes during the last two decades. The application of numerical control of machine tools brought about the mass production of machine products, reducing the labour force required on the shop floor and the potential of human failure in machining. Following this came the automation of plant operations around the production process e.g. in automated quality inspection. Parallel to that a reshifting in machining operations started by introducing multifunctional machining centres with automatic changes of tools and three-dimensional working capacity. Their introduction reduced the minimum lot sizes and increased the flexibility of production besides also reducing the labour force required.

The technological changes about to be massively applied after having gone through several years of development and testing are computer aided design (CAD) and computer aided manufacturing (CAM). Like the previous technological changes they indicate the growing importance for the economic viability of the engineering industry, small, medium or large scale, of planned efforts resulting in improved machinery, equipment and operations and reducing human intervention in the production process. These efforts belonging to what sometimes is termed 'intangibles', may be characterized as investment in planning, organization and human resources. They most probably will affect the SSIs in the engineering sector in two aspects:

- First, they will require a flexible response by the entrepreneures to the changing production environment, so that his business results remain unaffected;
- Second, they will represent additional business opportunities for SSIs, yet of a different type than what is commonly known up to now in the developing countries.

The group of intangibles of major importance in this context are operational planning, engineering design, product design and manufacturing software. For each of these computerized operations are characteristic. The development of computerized systems for operational planning and engineering design might in the future lead to the setting up of specialized engineering companies, with or without production capacity for specific products, e.g. in food processing, chemicals or equipment manufacturing. Product design and manufacturing software will most certainly be of great importance towards the end of the decade for the SSI in general. CAD and CAM will, together with the change to machining centres presently taking place in industrialized countries and already starting in Thailand (two cases are reported, one foundry and one machining company) alter the production potential of SSIs completely.

The described group of intangibles, especially CAD and CAM, will have a major impact on the development of the engineering industries in the developing countries. Besides the traditional small scale engineering industries with technologically relatively simple products a new type of small scale production industry will emerge: highly automated flexibly operating enterprises opening new manufacturing potentials of technologically complex products at international standards of quality.

Basically, the minimum size of enterprise would be determined by one machining centre; however, it would be desireable to install two machining centres to increase operation flexibility. Total investment costs in machinery and basic CAM hard and software would be around US $120,000 for two machining centres and employment created would be in the order of a dozen persons.

Such development could lead to considerably higher growth potential for the value added of the engineering industry as a whole, yet the effect on employment would be limited (although extremely positive for highly educated young professionals). Nevertheless, due to the reduced start-up time for new products or product lines the annual growth of employment over a limited period of time might be as high (as previously experienced in newly industrializing countries when computer applications were less advanced).

Mr. Plaetzer underlined that the technological change described above would bring about the existence of two categories of SSIs in the engineering sector:

- The traditional, labour-intensive enterprise manufacturing relatively low priced products of low technological complexity and low quality standards;

- The modern, more capital-intensive technologically advanced and flexibly operating enterprise using machine centres and CAD services, applying CAM and manufacturing products of international quality standards.

The categories would have different sales market conditions, requiring different marketing efforts, besides having completely different plant operations and machinery. This would demand an entirely different promotional approach: while the first category would need technical (and financial) support especially geared towards upgrading of skills and improvement of operations and products, the second category would require, above all, pre-investment guidance and a conducive environment in legal, fiscal and business servicing matters that will direct human resources and venture capital towards the creation of these new engineering industries.

(iii) Discussion

In the discussion following the two presentations Dr. Narongchai summarized the issues put up to the Seminar on the future development of Thailand's engineering industry sector. What was needed was a programme that would, firstly, allow for effective improvement of existing engineering industries and, secondly, promote the application of modern technology to a new kind of engineering firms. He most strongly felt that if Thailand were to catch up with and follow development elsewhere it was of utmost importance to most seriously consider the second area of promotion. This could be done side by side with the programme the RESCOM secretariat had developed for the existing engineering firms. The support for the modern technology engineering would require different approaches, different investment promotion, different financing and different marketing strategy.

On the future electronics industry development, Mr. Chaponniere in response to futher queries noted that the first step was to be in in the electronics industry; be it through foreign companies or local companies established on basis of subcontracting. In other words, these electronics industries should not be 'footloose', they should have a subcontracting link.

Dr. Narongchai noted that at the moment the Thai electronics industry consisted of two distinct groups; one was the 'offshore processing'. BOI had been inviting existing firms to expand and new firms to come in into this offshore processing mainly for exports and there were several firms now studying the Thai situation in this context. The main problem, according to Dr. Narongchai, was the lack of suitable sites (in spite of the fact that Thailand is such a large country). But to go further than the simple offshore processing, he thought, would be beyond many of these firms' intentions at the moment.

The other group of the electronics industry in Thailand was the smaller size firms which would somehow have to be connected with the final producers, through certain kind of subcontracting, manufacturing of replacement parts, etc. On the other hand, it seemed that the big offshore firms were not interested in local subcontracting arrangements; they were doing everthing by themselves in the country.

Dr. Chatri Sripaipan, Associate Professor, Faculty of Engineering, Chulalongkorn University, expressed support for the view that subcontracting was the first step, that is, assembling for consumer electronic products. Here the main obstacles lay in the Governmen''s sphere. A crucial factor is that the components imported reach the factory very quickly after their arrival in the country and that the assembled components go out of the country quickly; the turn-around time is very important in the electronics industry. If there are delays in this process nobody will be interested in investing. Another difficulty, which Dr. Narongchai also mentioned, is the question of factory location. Thailand has not been very successful in their industrial estates programmes. In the electronics industry one should be able to set-up a factory very quickly. The plant equipment needed is not heavy equipment. If there was readily available space for the plant provided with all the basic infrastructure, this would help a lot. Another very important factor is the availability of good telecommunications. In international subcontracting this is of vital importance.

Mr. Plaetzer added that product development and product design services, especially for the small-scale manufacturer, and assistance in this respect would also be quite helpful as an infrastructural support measure. This would mean that an agency or institution could take on (against payment) product development works for the small scale industry e.g. in respect of parts and components.

Dr. Somchob Chaiyavej, Vice Rector, King Mongkut's Institute of Technology noted that CAD/CAM was coming to Thailand, that was for sure. But considering the stage of development at this moment of the country's engineering industries, there was a long way to go. Some industries would be able to cope with it, but most industries would not without some sort of technical support. In this context Dr. Somchob especially draw attention to the possibilities, already mentioned, of university linkages.

Mr. Plaetzer, in response, agreed that there were, for sure, some small- or medium-size industries which had the entrepreneurial (and technical) capabilities of restructuring their operations, etc., in order to grow directly into very new areas, including being ready to enter into the CAM production processes.

Dr. Narongchai underlined that what was important now would be (i) how realistically we could expect that these new high technology systems (CAD/CAM and others) would be applied in Thailand and (ii) what would be the implication for the, so called, traditional small scale engineering industries. Would they be competing or would they be complementing?

Mr. Chakramon Phasukavanich of NESDB, noted that the overwhelming part of the small scale engineering industry in Thailand still belonged to the 'old generation', basing their activities on cheap labour rather than sofisticated machinery. So, if Thailand was going to pursue development of CAD/CAM and machining centres - within the context of small industry - then there would be a gap both to the Government extension service and the entrepreneur himself as the approach would, of course, require a great deal of support to provide finance for new machinery and equipment and new type of extension services to the entrepreneures.

Mr. Bandhit Hoontrakool of the Siam Nawaloha Foundry Co. Ltd. which has a machining centre, said that they had no problem in obtaining sofisticated new equipment like CAD/CAM, but they had big difficulties with getting people who could operate this equipment.

To this Mr. Wightman noted that in industrialized countries, e.g. in the U.K., there seemed to be a learning curve which in the case of the first installation was of the order of six months, while in an established machining unit the learning curve for another operator would be one to two months.

Dr. Somchob underlined the fact that CAM was now in Thailand - the Nawaloha company was just mentioned and there were other small factories who also had CAM systems. The facilities were really used for more effective and efficient production of complex parts and components (which often otherwise would not be possible to make eocnomically in the country). The direct effect on the country's employment was, of course, very small. Except in the sense that there was an increased need for qualified engineers. Indeed, in all the various units in Thailand having CAD/CAM, most of the time they stayed idle simply because there were not enough qualified engineers to look after them or even to handle simple programming, for example. Even in the selection of most suitable equipment many negative experiences had been made.

Mr. Plaetzer further clarified that, in his opinion, the traditional engineering sector should continue to grow as it had done so far. There would always also be a certain growth into new areas by some of these industrialists and there would always be some knowledgeable young people getting into the metal working production from scratch. The traditional and the modern high technology sector were not contrary to each other but complementary. The modern sector could capture a lot of the high quality engineered products which at the moment were imported. So, the country would just get an additional means or production aid.

Dr. Kovit Satavut, Assistant Professor, Faculty of Engineering, Chulalongkorn University maintained that the CAD/CAM and other related technological systems were just a logical development and a very fortunate one, as it makes the situation far better for smaller economies like Thailand's to be on a competitive level. CAD/CAM enables the small company to be as competitive as the big ones. It opens the possibilities of breaking into the domains of big industry, it makes it possible to produce engines and components which in the old days could not be made by small investment; now it is feasible.

Dr. Somchob in expressing strong support for development of high technology engineering industry side by side with further development and strengthening of the traditional SSIs in the sector, noted that, besides a few companies in Bangkok using computer systems for producing parts, car components etc., King Mongkut's Institute of Technology had already a machinery centre where personnel at technicians and engineering level were being trained.

V. DEMAND-RELATED ISSUES FOR THE THAI ENGINEERING INDUSTRY

(i) Increased utilization and transparency of the domestic market for engineering products

A brief note prepared by the Regional and Country Studies Branch, UNIDO, on demand for engineering products was first presented. It was observed that a crucial problem for engineering industry producers in developing countries was 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, could survive quite well through meeting fairly steady local demand, the demand for engineering industry work related to larger projects and higher quality items was usually satisfied through imports (which in Thailand's case corresponded roughly to 50 per cent of annual earnings from exports of all commodities). Consequently the spin-offs which might be expected from greater engineering products demand in terms of technological upgrading, expanded inter-industry linkages, greater employment and foreign exchange savings were (though difficult to qualify) almost certainly much weaker than they should be.

The note presented was intended to indicate some of the issues related to the possibilities of meeting more effectively this domestic demand for engineering industry products with local manufactures. It was noted that the present period provided a confluence of conditions which virtually would compel the administration to formulate and implement a strategy for encouraging demand for locally produced engineering industry items. These conditions were:

- 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 was bound to be affected;

- a renewed effort by enterprises in OECD countries to sell engineering industry products in developing country 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 engineering industry items whose economic life is now shortened;

- the initiation of a major drive for big investment projects located on the Eastern Seaboard. These created a unique 'bunching' of investment expenditures which were quantitatively enormous, likely to be maintained over a long period, contain a substantial element of public sector outlays, and yield a fair proportion of engineering industry products which were common to the diverse projects (i.e. even where sectors for the projects differ, construction and other expenditures would be for similar sets of products);

- the Government was publicly committed to a programme of industrial restructuring for which it had received financial backing and in which an institutional apparatus had been created and was functioning.

Taken together, these conditions added up to a context of both considerable opportunities and considerable risks. The Government must decide whether it wanted to take an active role or not in a reorganization process that had already begun and was bound to become much more pronounced in the next few years. If the decision is in the affirmative, than the problems would centre on the orientation of public sector demand and of private sector activity. Whatever the source of demand, two kinds of information would be required as a basis for future policy.

The first is of a factual nature: what were the reasons for preferring foreign-produced engineering industry 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 was known to be chances for domestic as well as foreign sourcing, a reasonable mapping of the obstacles to raising local contant could be made.

The second type of information concerns objectives: Are there priorities for favouring particular areas of engineering industry production? To answer that implicitly if not explicitly would require the Government to adopt a strategic approach to the engineering industry sector. 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 engineering industry products where Thailand might have export possibilities, or through other means.

This empirical work would allow an estimate of the extent and nature of engineering industry 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 developing countries, is the creation of domestic engineering consultancy enterprises. Their functions are well known: to prepare techno-economic pre-investment studies, to carry out the engineering works in investment projects; to identify sources of supply of plant and equipment for the project; to ensure that timetables and schedules are adhered to; to assist in the negotiation of contracts with suppliers; to manage the setting up of the plant and to advise on the testing and running in of equipment. Domestic involvement in this process can initially best be effected through increasing 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.

The essence of the effort of developing engineering counsultancy, then would be to use it as a bridge to orient demand towards the better sources of domestic supply; localization of services would be taken as an investment through which to raise local content. This approach would be project oriented and would of course be of less direct use for engineering industry products where demand is not related to new investments.

As a measure of broader scope it was suggested that consideration may be given to the feasibility of establishing trading houses devoted to engineering industry products which may be able to channel demand towards local suppliers.

In the discussion following the presentation Dr. Narongchai drew attention to the issue of use of local content requirements as a means of increasing demand for local products. Mr. Plaetzer noted, referring to experiences in developing countries elsewhere, that, no doubt, local content requirements can increase domestic supply of components to complex products. At the same time experience has shown that all parties involved often tend to overprice the local products, resulting in that the actual level of local content can be very diffuse.

Dr. Rachain Chinthayarungsan, Lecturer at School of Economics, NIDA, with reference to the engineering industry study his team is carrying out for the RESCOM secretariat, felt that, regarding the products within the scope of that study (which does not for instance, cover automotive products), certain potential for local content might exist for products like engines and turbines, although the study team had as yet not looked at specific products.

Mr. Chakchai Panichapat of the Board of Investment noted in this connexion that the local content requirements introduced for diesel engines for agricultural purposes had been quite successful in fulfilling their purposes of enhancing local component production. The results in the case of the automotive industry were less clear.

Dr. Somchob draw attention to the fact that standardization of parts and components could be a means of creating demand and that there was a need for establishing standards or norms of production for such items.

(ii) Government procurement policy with special reference to engineering industry products

Dr. Narongchai presented a paper prepared by the RESCOM Secretariat on Government procurement policy with special reference to engineering industry products.[1/]

The role played by Government as purchaser of goods and services could, he noted, be quite influential for the development, and structure of the industrial sector. The quantitative importance of such purchases was highly variable from one industry to another. As examples of products where the Government was the major buyer in Thailand could be mentioned telephone apparatus, electrical wires and cables, electric transformers and insulators. To a lesser extent Government procurement could promote local producers of other engineering products, e.g. water pumps, steel pipes and pipe fittings, gate valves, power generators, machine tools, construction equipment and transportation equipment.

1/ Issued by IMC as Paper No. 4 prepared for the Seminar on Engineering Industries in Thailand, Bangkok, 5-6 November 1984.

The Thai Government used competitive bidding for its procurement and offered a 15 per cent preference for local products over foreign proudcts, provided that the products had certificate of standard and were registered as local products at the Ministry of Industry. In the RESCOM Secretariat paper it was noted that the existing procurement system had been found to be more than adequate for the locally promoted engineering products (as also around 30 per cent tariff protection would come in). Still local producers had claimed that Government procurement did not give them enough preference.

The study concluded that Government procurement practices were subject to several criticisms, in particular, that:

- the Government uses the criteria of lowest prices solely as base;
- the invitations to tender are occasionally on short notices;
- product requirements and specifications are rigid and seem often to favour the product of a certain producer; and
- Government procurement has not been designed to systematically promote local industries; in other words, long-term planning of state purchases is lacking.

In the subsequent discussion, Dr. Narongchai elaborated on the protection issue. The domestic protection, at between 30 and 45 per cent, would seem to be quite sufficient, and that would be the case when the procuring Government agencies were using their own funds and other local funds they might be able to mobilize through loans. However, a lot of financing was made through bilateral or multilateral sources, where only the 15 per cent margin might be relevant or in some cases (e.g. OECF) not even that. The method of determining prices for comparison varied among different funding sources as follows:

	Sources of fund	Prices to be compared	
		Local	Foreign
(i)	Foreign loan		
	- OECF (Japan)	Factory price	C.I.F. price
	- World Bank	Factory price	C.I.F. price plus expenses not exceeding 15 per cent of C.I.F. price
	- Federal Rep. of Germany	Price delivered to buyer's godown	C.I.F. price plus taxes and expenses delivered to buyer's godown
(ii)	Local loan	Price delivered to buyer's godown	Price delivered to buyer's godown plus 15 per cent
(iii)	Own fund	Price delivered to buyer's godown	Price delivered to buyer's godown plus 15 per cent

Dr. Chatri noted that local producers were arguing that the 15 per cent protection was not enough in the frequent cases where the local producer had to use, to significant extent, imported materials and parts and these materials and parts were often subjected to even much higher import tax rates.

Dr. Chatri also commented on the question of the specifications given in the tenders, and the desirability that some measure of control could be applied there. (The specifications were written by the departments which wanted to purchase the items. For instance, some specifications demanded experienced producers, that is, they had to verify that the product had been used elsewhere during a certain number of years, etc.; in some specifications it was even mentioned that the product should come from certain countries.) Dr. Chatri felt that it might be most helpful if the Government agencies could establish long-term requirements (on basis of the development plan or projections) and that these be made known to producers. He also noted that some other countries had used the approach of having tenders for certain

equipment only once every five years. The winning firm could then set up and plan production during such time frame.

In the further discussion it was noted, inter alia, that the Board of Investment did not approve duty exemption (to promoted firms) for such machinery and equipment items which were produced in the country, should the promoted firm choose to import such items. The Board of Investment had devoted considerable efforts in making known to all promoted companies what kinds of machinery and equipment was available in the country.

(iii) Strategy for developing versatile exports in manufacturing of engineering-based products

Mr. Eric Wightman, UNIDO adviser, presented his paper relating to exports development in the engineering industry field.[1/] He suggested that to bring about any significant change in the engineering sector would require:

(i) establishment of a world wide market intelligence to identify and assess market opportunities;

(ii) supply of capital to invest in selected national projects;

(iii) creation of an effective organization for continously keeping up-to-date from technological point of view existing designs and to develop new ones;

(iv) minimizing the cost of all raw materials which require to be either imported in a finished state or a raw state.

Mr. Wightman then draw attention to the close linkages existing between a dynamic engineering sector and the scientific or research and development community. Technological advances were made in the scientific areas first, then applied to products, although there are many examples where the search for cost reduction has motivated the research. Another important aspect was the blend of scientific disciplines. The step from a purely mechanical product to a purely solid state micro processor is very much the work of the multi-disciplined technical entrepreneur. Thus, any policy for furthering technological transfer or growth would require implementation through specialists in technological disciplines (as distrinct from product

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1/ The full text of the paper is appended as Annex 7.

specialists). The dangers of relying on imported technology through the medium of kits of parts which are only assembled locally could not be over emphasized.

Mr. Wightman stressed further the need for a bridging between the universities on the one hand and manufacturing companies on the other, and felt that there was a strong case for setting up a Manufacturing Centre of Technology which in effect would be an advanced manufacturing pilot plant for rapidly converting new products to prodution, to illustrate the viability of new and improved products and processes.

Of crucial importance for the envisaged further development of the engineering industry would be the responsiveness of the manufacturing units to become versatile and economical in small batch production. Incentives may be required to encourage an influx to the industries of new graduate engineers able to directly contribute to the introduction of new methods, materials and machines into the traditional environments. These might be a need for a 'National Technology Awareness Promotion Scheme' to foster this approach.

In conclusion, Mr. Wightman stressed that if Thailand was to opt to use latest computer controlled machines and management computer aides (e.g. CAD/CAM etc.) there would, of course, still be an immediate cost advantage on anything made here because of low labour cost per work per hour. These machines are available off the shelves, the know-how too is available and the operators can be trained relatively quickly. Manufacturing fields of immediate interest would be found in the machinery sector, automotive sector, and in manufacturing of products such as tractors, machine tools, pumps etc. Major items for such machining centre might be e.g. for engines, crank cases, cylinder blocks, fly wheels, crank shafts, while all the very numerous small items required would be made by the existing small-scale engineering industries.

In the following discussion main attention was given to the potentials of flexible production systems and the proposal for setting up a machining centre or advanced manufacturing pilot unit.

Mr. Wightman noted that e.g. the engine manufacturers in the U.K. were now busy restructuring their manufacture around computer controlled machinery centres. The whole machine tool industry in the OECD countries has switched over to such flexible machining. One example mentioned, was a plant which had diversified to making turbines, pumps, engines and machine tools in the same factory.

The investment costs for a plant making say 70,000 engines per year (and assuming all small parts were made in other existing plants) would be around Baht 40-50 million according to Mr. Wightman. If the same products were to be made with traditional machinery the investment would be ten times more (and the requirement for large scale production correspondingly higher in order to arrive at scale economy).

VI. SUPPLY-RELATED ISSUES FOR THE THAI ENGINEERING INDUSTRY

(i) Technology for development of engineering industries in Thailand

Dr. Chatri Sripaipan, Associate Professor, Faculty of Engineering, Chulalongkorn University, presented his paper on technology for the development of engineering industries in Thailand.[1/]

The Fifth National Economic and Social Development Plan 1982-86 had for the first time, included a chapter on the utilization and development of science and technology and targets had been set up related to the ratio of expenditures on R and D to GNP (0.5 per cent increase per year). The Plan also foresaw special incentives to industry engaged in R and D.

The technologies required for the production of engineering products depended on the activities involved. In production engineering, technologies such as production control, and quality control were not highly product specific but product testing was. The technologies required in capital goods manufacture were firstly basic manufacturing technologies which consisted of mechanical processes such as casting, forging, heat treatment, welding, machining and metal forming and of chemical process such as plating. An engineering product probably needed a few of these processes plus other processes that were specific for the product. R and D and design and engineering required highly specialized knowledge in the areas of application of the product. In building up the country's technological base, one should invest in technologies that were not product sensitive. The mechanical and chemical processes were required in order to build up a good manufacturing base. Up-to-date technologies must be aimed for.

In summary, the technologies Thailand needed most at present were those relating to basic manufacturing in order to build up a strong manufacturing base. There was a need for a comprehensive technology policy. It should address the issues of optimisation of technology flow, technology diffusion, technical manpower development, research and development system, industrial standard system and financial instrument and fiscal incentives.

1/ Issued by IMC as Paper No.5 prepared for the Seminar on Engineering Industries in Thailand, Bangkok, 5-6 November 1984.

(ii) Product development and quality upgrading

A short note prepared by the Regional and Country Studies Branch, UNIDO was presented concerning certain issues regarding product development and quality upgrading in the Thai engineering industry.

One of the characteristics of engineering industry projects was 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 was the spontaneous and progressive up-grading of skills and technology associated with the production process. Development support and assistance should be geared accordingly.

The growth of the engineering industry sector, even in the context of import substitution, depended 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 took place was the focal point for upgrading skills and technology; institutionally, it could be regarded as an actual or potential source of numerous production activities.

Technological and design institutes played an important role in the diffusion of advanced techniques and design, the adaptation of foreign technology to local conditions and the study of 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 engineering would develop within a country, it may prove desirable to increase specialization and to split a single technological and design institution into several specialized branches. Training of technical and design personnel would go hand-in-hand with this process and would involve close links between the institutes and the universities in the country.

The technological work related to product development and quality up-grading generally required by industry would fall 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.

In the note some problems of the Thai engineering industries, were discussed such as lack of design and product development-related capabilities, and the fact that little attention was paid to quality control and standards. Another factor was the weak condition of many of the basic support industries in the engineering sector, particular foundries and forges.

In the ensuing discussion particular attention was paid to the suggestion for a programme to improve quality standards which 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 was also suggested that the private sector could 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 had both good quality and a good reputation in the local and overseas markets.

VII. FINANCING ISSUES FOR ENGINEERING INDUSTRY DEVELOPMENT

At the first session of the second day of the Seminar a paper prepared by the RESCOM Secretariat, entitled 'Financing issues for engineering industry development',[1/] was presented by Dr. Pairoj Vongvipanond, Assistant Professor, Faculty of Economics, Chulalongkorn University.

The paper focused on the financial dimension and related issues of the Thai restructuring programme against the background of the general objectives of industrial restructuring to alleviate or remove existing inefficiencies in the use of resources and to improve the competitive position of the firms. In this context the engineering industries would deserve special attention, according to the RESCOM Secretariat paper, as

(i) engineering products accounted for a large part of the country's inputs (roughly 37 per cent in 1980);

(ii) engineering products comprised a very large and hetrogenous group of products; many of them were standardized and relatively simple to produce; thus there were many products that the country could (a) produce and substitute efficiently for imports, and even (b) develop export markets for (e.g. for parts and components);

(iii) a number of these products could be produced efficiently at small scale;

(iv) although they tended to be labour-intensive, these products were also skill-intensive and the lack of efficient skilled labour could impair their ability to develop;

(v) there were strong linkages, both backward to supplying industries and forward to end users, among the engineering products.

The paper noted that there was strong demand for long-term finance to serve the industrial restructuring efforts but that the present financial institutions and market were not well equipped to meet this demand.

In recent years, however, there had been growing interest on the part of the Government and of the donor community in promoting the Thai engineering industries as a necessary adjunct to industrialization, a source of

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1/ Issued by IMC as Paper No.6 prepared for the Seminar on Engineering Industries in Thailand, Bangkok, 5-6 November 1984.

employment and for technological development, and the Government was now considering an institutional arrangement for making credit available to engineering industries. It was maintained that for effective engineering industries development to be successful, availability of finance at special terms plus subsidy in the form of technical assistance was crucial. One proposal was to establish an industrial restructuring fund or a sector loan programme to be set up as a separate entity with its own account, managed by a suitable institution and channelled to targeted industries. Such a sector loan programme would initially be confined to the engineering industries' restructuring but later, if successful, it might be expanded to the whole industry. The project would thus involve (a) a source of investment funds to rationalize and modernize existing plants and to assist new ventures and (b) technical assistance on the production floor to improve the use of current resources and labour and management on-the-job to increase productivity. To be specific, the proposed sector loan programme for promoting the engineering industries should be designed to:

(i) improve the technological capabilities and competitive position of a core of large enterprises;

(ii) increase the amount of subcontracting to the small and medium scale engineering firms so that the development impact would be spread throughout the sector;

(iii) increase efficient substitution for import; and

(iv) increase the efficiency of other sectors that are related closely to the engineering industries.

Under this sector loan programme, the projects should be developed on the basis of a detailed sector review which would identify a preliminary list of products, including production of components and subassemblies, that would appear to be in a relatively favourable position for initial emphasis. The criteria used for such selection would include: (a) A strong market demand, both domestic and with export potential; (b) sharing of common inputs which also strengthen the market for components, and complementarity in marketing; (c) favourable technical conditions in the plants so that existing cost disabilities can be readily overcome with some additional assistance; (d) product characteristics that do not impose too great a requirement for technical advance; and (e) enterpreneurs who are prepared to make changes in their current practices.

There would be a strong element of institution building involved in the effective implmentation of such a sector loan programme. The paper suggested that the Industrial Finance Corporation of Thailand (IFCT) would be the best institutional choice in terms of accummulated expertise in both mobilizing funds from foreign sources and in industrial lending. Since March 1984, IFCT had had a special credit programme for small-scale industries. IFCT also had a special programme for efficiency and productivity improvement and a special programme for energy saving to provide technical assistance - managerial and engineering - for the industry when necessary. In co-operation and collaboration with various technical institutes concerned, such as TISTR and King Mongkut's Institute of Technology (and the proposed engineeing industries development institute) extensive programmes of technical assistance could be injected to the industries under the loan programme.

It should be noted that in the proposed model IFCT would lend directly to the engineering industries. However, this would not exclude the possibility that IFCT could function as intermediaries in mobilizing and channelling funds to other financial institutions which would relend to the designated industries. The role of the Ministry of Finance would be to provide initial seed capital, guarantee programme borrowing and assume foreign exchange risk. Funds from both domestic and foreign sources would be drawn. There would in the case of foreign borrowing the necessity that IFCT seek the optimum financial and technical assistance package from diversified sources, e.g. multilateral institutions and bilateral sources.

To sum up, ways and means were being sought to improve the mobilization and channelling of financial resources for structural adjustment. In the context of industrial restructuring in the subsectoral level, the engineering industries would be accorded top priority, and to meet the restructuring targets, a sector programme for the engineering industries should be designed and formulated. Of particular importance would be the active participation of the Government and the development financial institution(s) in promoting and strengthening the competitive edge of the industries, through a sector loan programme to provide a package of financial and technical assistance to the engineering industries.

In the subsequent discussion, Dr. Narongchai observed, that, assuming Thailand adopts the engineering industries to be a leading sector, the question would be whether the Government had the financial instruments or means to promote this industry accordingly, and the answer would be no, judging from existing system and institutions. The Government had, of course, through the Bank of Thailand a discount facility to certain priority industries, but this channel was difficult to operate on any scale; the Bank of Thailand not really being in the position to do this kind of work. The second institution the Government had interest in was the IFCT. But IFCT was basically a private institution (with shareholders' interest to satisfy) although it had been set up by the Government. So, therefore the possibilities of IFCT to promote engineering industries in terms of special financial support were limited. Taking all this into account the RESCOM Secretariat, Dr. Narongchai noted, had tried to look at alternatives which were reflected in the paper presented by Dr. Pairoj, namely:

(i) The Government was to mobilize funds and request the Bank of Thailand to channel funds to the industry through existing financial institutions. (This had not seemed to be the most suitable or practical alternative.)

(ii) The Government and the Bank of Thailand would do the fund mobilization and put these funds into something like an industrial development or industrial restructuring fund, to be managed by somebody (one possibility, as Dr. Pairoj had mentioned, being IFCT) and then channel this fund to the public, to the industries, through existing institutions, such as IFCT, commercial banks etc. (This alternative was now being discussed as the long-term approach.)

(iii) The Government and the Bank of Thailand would do the fund mobilization and request the IFCT to do the channelling to the public; key industries would be designated. (This might be the most practical short-term, immediate arrangement.)

In response to further queries, i.a. whether any specific attention would be given to small-scale industries and regarding the time-scale for possible sector programme lending, Dr. Narongchai noted that small scale engineering industries would, certainly, be included in the scheme as the key industries were designated. As for timing, he drew attention to two schemes or projects presently being discussed relating to engineering industry support, one with the USAID and another with the World Bank, both possible for implementation in 1985. Furthermore, of course, if the Government would determine that

engineering industries be the so called leading sector for the 6th Plan term 1987, then the Government would be expected to make certain allocations either through the budget or through Bank of Thailand for the Plan period.

Dr. Narongchai (as well as others taking part in the discussion) noted that the carrying out of such sector programmes, would require further analyses (e.g. by the RESCOM Secretariat) regarding key industries or subsectors within the engineering industries.

VIII. TOWARDS A LONG-TERM PERSPECTIVE FOR THAILAND'S ENGINEERING INDUSTRY AND REQUIRED POLICY MEASURES

At the second (and final) session of the second day of the Seminar a general review and discussion was held on the long-term perspective for Thailand's engineering industry and required policy measures on the basis of the preceding discussions during the Seminar.

Dr. Narongchai noted that the outcome of these discussions, it was expected, would give guidance to what should be proposed to the Government in terms of policy direction, strategy and measures for the promotion of engineering industries. In view of this Dr. Narongchai referred briefly to the current thinking on the Government side concerning industrial development in the context of the forthcoming 6th Plan (as well as the remaining half of the 5th Plan period). The present policy direction was that there was going to be basically three major so called priority sectors or categories of industries, namely

1. Export-oriented industries (which would encompass a number of different types of products);

2. Small and rural industries or industries located in areas outside Bangkok and surrounding area;

3. "Leading" sectors:
   (i) engineering industry
   (ii) agro-based industry.

Thus, the engineering industry, being designated as one of the "leading" sectors, was very much part of the overall Government industrial development policy. What was needed to be done before the Government could actually announce or set guidelines for the development of this designated 'leading' sector, would be to define a very specific strategy concerning e.g. the traditional engineering industry sector and the modern sector, moving towards high technology, as discussed earlier at the Seminar. Some of the key measures to be adopted for the promotion of this particular sector would also have to be identified. Several of these measures had been discussed in some depth, e.g. measures towards the creation of expanded local demand, Government procurement, promotion of technology, provision of financial support.

The UNIDO-team had on basis of the Seminar discussions prepared following brief note which in effect listed in a structured manner these points regarding the strategy as well as measures for achieving desired development in the engineering industries sector:

Elements for proposed programme of action for the engineering industry sector

The diversity of engineering industry both in terms of the range of products produced and processes employed as well as the breadth and resilience of the enterprises involved, compels the Government to acquire a considerable knowledge of the sector before policy measures are launched.

The effective development of a concerned engineering industries development programme will be expected to rely considerably on the mechanisms of Government/enterprises co-operation.

Specific programmes may be developed in following areas:

1. Information, market intelligence, etc. Collection and dissemination of information on:

   (a) domestic demand (Government and others)
   (b) domestic capabilities
   (c) export potentials, international marketing
   (d) trends in technology development.

2. Promotional requirements for engineering industry development in the case of:

2.1 The traditional, mainly labour-intensive manufacturing enterprises:

   (a) Assistance or extension services in general areas such as

      - production technology (plant layout, use of tools and fixtures, etc.)

      - financial planning (including formulation of loan applications and strengthening of self-financing through reallocation of resources within the enterprise)

      - accounting, cost calculation and sales price fixing;

   (b) Provision of suitable credit facilities, schemes of leasing machines and equipment;

   (c) Promotion of subcontracting and complementation;

   (d) Special technical services, access to technology through technology transfer;

(e) Furthering measures for product standards and quality control;

(f) Support to the creation of branch associations and co-operation in marketing efforts, (e.g. fairs, preparation of buyer's guides);

(g) Training courses.

2.2 The modern, technologically advanced and flexibly operating enterprises, using machine centres and CAD services, applying CAM and manufacturing products of international quality standards:

(a) Human resources development (high level skills in informatics and engineering);

(b) Investment in technology;

(c) Provision of credit and Government guarantee facilities;

(d) Creation of appropriate business environment (including investment incentives and promotion);

(e) Information on technological advancement of the machine industry, computer industry and software developments;

(f) Pilot (high technology) machining unit with CAD/CAM, facilities to demonstrate the benefits and potentials of and capabilities to use high technology[1/].

3. Selection of strategic products (predominantly capital goods) suitable for the modern high technology engineering industries:

(a) Set of parts and components as examples for flexible machining (e.g. gears, shafts, casings, couplings);

(b) Set of products as examples for flexible machining (e.g. engines, machine tools, pumps, generators up to 20 kW);

(c) Communications and electronics equipment

(d) Design and manufacture of tooling:

- metal cutting
- dies
- moulds
- chucks
- jigs and fixtures;

1/ Pilot machining unit with CAD/CAM facilities:
- 2 computer controlled machining centres with 40 station tool-changers
- 2 computer controlled general purpose bar/chucking lathes
- 1 CAD/CAM system for processing from design to manufacture.

(e) Woodworking machinery.

4. Promotion and support for standards and quality certification measures, in particular testing facilities.

5. Government procurement, in particular to:

   (a) Investigate the potential of Government purchasing for the promotion of engineering industry;

   (b) Assess the capability of the local industry to produce the wanted products;

   (c) Provide information of the next 5 years' requirements of products, including specifications;

   (d) Activate industry's own informative and marketing efforts towards Government purchasing;

   (e) Carry out intensive testing programmes for locally produced items to demonstrate product aptitude and fulfilment of quality requirements.

6. Creation of domestic engineering services to orient the demand towards the better sources of domestic supply by planning and supervising the installation of processing plants, including:

   - working out the organization of engineering projects;
   - identifying sources for the various components of the project;
   - assisting in negotiations in contracts with suppliers.

7. Public information, effective use of various means of communication (press, radio, TV) to inform on high technology.

The discussion that followed the presentation of the note was opened by Dr. Narongchai who noted that the guidance of the Seminar in pointing out and commenting on the various issues or aspects dealt with would be of great value for the fulfilment of the tasks of the Industrial Restructuring Committee (RESCOM) in the field of engineering industries development. The areas identified in the note for which specific programmes may be developed were taken up one by one in the discussion.

Regarding the first area - collection and dissemination of information, market intelligence, etc. - the importance in acquiring fullest possible knowledge of the sector both for the benefit of the policy makers and for the industry itself was fully recognized.

The second area - promotional requirements for engineering industry development - was subject to very lively discussion. In noting that the promototional requirements had been identified in the note in respect of two types of engineering industries - on the one hand the traditional, mainly labour-intensive manufacturing enterprises and on the other hand the modern, technologically advanced and flexibly operating enterprises - Dr. Somchob suggested that there was an important group somewhere in between, namely a few factories, the existing machine tool industries and others, which were doing very skill-intensive work and which also needed support. This, Mr. Wightman felt was a very valid point. At the same time, in the case of the machine tool industry it would seem that it could benefit greatly from the introduction of high technology manufacturing methods. Hopefully one could look at the task of modernizing and developing the machine tool industry sector as a key project with the knowledge that the sector's performance could become much strengthened with the aid of high technology manufacturing systems.

Dr. Narongchai noted that in the context of "creating of appropriate business environment" for the modern, high technology engineering industry sector (item 2.2(d) in the note) the efforts on the Thai Government side in terms of various fiscal and other incentives should be included, and would be considered an essential part of the business environment.

The criteria by which the selection had been made of strategic products suitable for the modern high technology engineering industries - the third area in the note - were elaborated on by Mr. Wightman as those parts or products which have the maximum backward, forward, sideways linkages with other products requiring similar materials, processes, manufacturing and technology, e.g. engines, machine tools, pumps and products that particularly required same materials, such as castings, forgings, and for the same machinery processes (at the machining centres). Another group of products, highly specialized, would be communications and electronics equipment. Furthermore, included in the listing were elements of a tooling industry which would lend themselves for development within the existing small scale industries - whether it would be in metal cutting, die making, wire extending, mould making for plastics or sheet metal or jigs and fixtures which were needed for assembly of engineering products.

To this listing had been added in the note as suitable products, woodworking machinery. It was also generally agreed in the discussion that certain types of textile machinery could be added as another item (or, as Mr. Wightman suggested, be included among machine tools because the requirements for design and manufacture were similar). Farm machinery and farm tools was still another group of suitable products.

It was noted by Mr. Spreafico, that textile machinery represented very substantial amounts in the imports of the country. Not all the textile equipment had very high technology. Many machines could be manufactured in Thailand, especially for replacing old machines, to avoid bottlenecks, etc.

Dr. Kovit draw attention to the specific problems in the agricultural machinery sector, namely, that the demand is very seasonal - only 3-4 months per year. It was suggested that suitable special credit facilities might be established to help the manufacturers to be able to maintain a steady level of production (by producing and carry in stock in between the seasons and relaying on the relatively predictable seasonal demand). It was also suggested that the agricultural machinery manufacturers might try to diversify (in simple products) e.g. in certain simple textile machinery during the slack periods.

In response to a query by Dr. Narongchai on what might be included from the policy makers point of view in engineering industries as "leading" sector, it was generally agreed that

- it should essentially comprise capital goods and the intermediate products used for their production;
- it should not include the materials (iron and steel, etc.);
- it should not include downstream products like consumer electronics. (Within the electronics industries there would be microelectronics, integrated circuits, TV tubes, capacitors, resistors, etc., and they tended to be very specialized. They would warrant a sector of their own);

Regarding the fourth area - standards and quality certification measures - Mr. Chaiwai reiterated the importance and urgency of improved testing facilities. He also suggested that a helpful further tool for the Thai manufacturers - in particular the small industry - would be the use of the

Thai standards books in technical promotion, by including guidance on how to achieve the set standards. Such suggestions and illustrations of methods were provided, for instance, in many British and Japanese standards books, while the Thai standards books had been stricktly confined to stating the standards specifications established (length, tolerance, characteristics and properties of the products). Mr. Chaiwai noted that in TISI's experience many industry owners were at a loss over how to achieve a required standard even in fairly simple straight forward instances. A main problem was that there was nothing practical available in the Thai language; the university text books being not enough precise and simple. The manufacturer is interested in how, not why. It would go a long way, Mr. Chaiwai felt, if some of the English or Japanese books were translated.

Regarding the fifth area - Government procurement - Dr. Narongchai suggested that what was intended to be done was perhaps a little bit more than was indicated in the note. RESCOM wanted to investigate the possibility of adopting Government procurement as a means for promoting local demand for certain engineering products. With financial support from USAID, the Association of Thai Industries was now undertaking a detailed study on this matter, including suggested policy measures, for submission to the Government. Thus, there would be more done than assessing the capability of local industries for this purpose and providing systematic information on requirements.

Mr. Chaiwai, furthermore, noted that the Government had issued policy guidance to all government agencies as well as to the public sector enterprises to favour products with the Thai standards mark. For cases where no Thai standard existed, the Government had set up a committee to look into the locally manufactured product. If the product was accepted and registered by this committee it would receive the same treatment as those with the standards mark, and also getting the 15 per cent price advantage over the lowest non-local bid. But unfortunately these measures did not apply (necessarily) to projects financed from international loans.

Regarding the sixth area - creation of domestic engineering services - Dr. Narongchai noted that RESCOM had looked into this, especially in terms of institutional arrangements. It was recognized that e.g. TISTR might have

required expertise and be suitable to provide the required services only in certain areas. The Ministry of Industry had also been in the process of setting up an engineering industry development institute which was to provide technical assistance services, consultancies etc. Japanese bilateral aid was envisaged for the establishment of this institute, to be called the Metal Working Development Centre.

Mr. Ramm-Ericson noted that one important aim would be to stimulate private sector or commercial consultancy services, or such services by a semi-public institution like TISTR (able to operate on a fee-basis for rendered services). Mr. Chakramon suggested in this connexion that one could try to apply the concept of local content in terms of services. E.g. the Government might rule that major foreign consultancy services would have to be carried out through the form of a consortium which would include Thai consulting firm(s).

Dr. Narongchai felt that the main difficulty was that the engineering services required by the local industrialists were too expensive if provided through private consultancy. It was at the same time clear that in order to give this service you needed to have very high expertise; the Government institutions could not really sustain such highly qualified people. At IFCT, for example, a scheme of subsidizing such services for up country clients had been initiated. This was financed in such a way that IFCT had set aside a certain percentage of loan funds (under a loan from FRG with very low interest) for the purpose of paying the fees and sometimes the travel for teams of experts, while the local entrepreneur would pay the local costs only.

Mr. Wightman suggested that perhaps a small surcharge, say, 1 per cent on top of the 15 per cent import duty on certain products, say, capital goods might be collected and set aside for promotional purposes (for import substitution in the field of engineering products).

Dr. Narongchai, noted that in response to queries regarding the availability of local consultancy capabilities, that, for instance, IMC had established comprehensive listings or registers of consultants and specialized expertise in Thailand and was making good use of them. A system of

accreditation of engineering consultancy (as well as of the earlier discussed testing services) should be most useful.

In conculding the Seminar Mr. Ramm-Ericson and Dr. Narongchai reiterated the very high priority accorded to the engineering industry sector. The RESCOM was being the central forum for consideration of various proposals on how to develop the sector, including aspects concerning the standards and testing system, R and D, and technology promotion schemes, as well as how to effectively meet the financial needs of priority development of the sector.

Dr. Narongchai also stressed the fact that the RESCOM would also very soon be in the process of contributing to the work on the 6th Plan, where engineering industries were expected to be accorded high priority and adopted as 'leading' sector. The subjects discussed during this Seminar would form basis for the sector development plan or programme, which would be prepared by RESCOM to serve as input to the Sixth Five-Year Plan.

Annex 1(1)

PROGRAMME

FOR

RESCOM - UNIDO

SEMINAR ON ENGINEERING INDUSTRIES IN THAILAND

5-6 November 1984

Hyatt Central Plaza Hotel

Bangkok, Thailand

Monday 5 November 1984

0900 Opening address by
Dr. Praphas Chakkaphak, Perm. Secretary, Ministry of Industry

0915 Current State of the Engineering Industries

1. Overview
Speaker: Chatri Sripaipan

2. Issues of Consideration in the Light of Recent International Trends in Engineering Industry
Speaker: Nils Ramm-Ericson (UNIDO)

3. Metal and Metal Product Industries
Speaker: Rachain Chintayarangsan

4. Machinery Industry
Speaker: Boonwa Thampitakkul

1100

1. Electronics Industry in ASEAN and Republic of Korea - Some Issues
Speaker: J.R. Chaponniere (UNIDO)

2. Small Industries' Role in Engineering Sector
Speaker: Karl Heinz Plaetzer (UNIDO)

1400

1. Increased Utilization and Transparency of Domestic Market for Engineering Products
Speaker: Nils Ramm-Ericson, (UNIDO)

2. Government Procurement Policy with Special Reference to Engineering Industries Products
Speaker: Narongchai Akrasanee

3. Strategy for Developing Versatile Exports in Manufacturing of Engineering-based products
Speaker: Eric J. Wightman (UNIDO)

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1600 1. Technology for the Development of Engineering Industries in Thailand
Speaker: Chatri Sripaipan

2. Product Development and Quality Up-grading
Speaker: Nils Ramm-Ericson (UNIDO)

Tuesday 6 November 1984

0900 Financing Issues for Engineering Industry Development
Speaker: Pairoj Vongvipanond

1000 Towards a Long-term Perspective for Thailand's Engineering Industry and Required Policy Measures
Speaker: The UNIDO Experts

1100 Summary, Conculsions and Future Plans of RESCOM
Speaker: Narongchai Akrasanee
Nils Ramm-Ericson (UNIDO)

Annex 2(1)

RESCOM-UNIDO
Seminar on Engineering Industries in Thailand
5-6 November 1984
Bangkok

LIST OF PARTICIPANTS

Industrial Restructuring Committee

Dr. Praphas Chakkaphak	Permanent Secretary, Ministry of Industry
Dr. Narongchai Akrasanee	Managing Director, The Thai Industrial Management Co. Ltd.
Mr. Chokechai Aksaranan	Honorary Secretary General, The Association of Thai Industries
Mr. Chakramon Phasukavanich	Chief of Industrial Planning Sector, Economic Projects Division, NESDB
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Mr. Chalerm Amornphan	Economist, Policy and Agricultural Development Plan Division, Office of Agricultural Economics, Ministry of Agriculture and Co-operatives
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Mr. Insorn Pinkayan	Director, Industrial Service Division, Department of Industrial Promotion
Ms. Orapin Werawut	Director, Planning Division, Department of Industrial Promotion
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Mr. Patibhan Ariyadej	
Mr. Jan Swerts	(Observer)

Annex 2(2)

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Ms. Pranee Yasasindhu	Director, Planning Division
Mr. Chakchai Panichapat	Director, Project Development Division
Mr. W.R. Fothergill	(Observer)
National Economic and Social Development Board (NESDB)	
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Mr. Visit Boonyakesanond	Director (Acting), Technology and Environmental Planning Division
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Mr. Rungrapi Metaneesadudee	(Observer)
Ministry of Commerce	
Mr. Pitsanu Rianmahasarn	(Observer)
The Bank of Thailand	
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Industrial Finance Corporation of Thailand (IFCT)	
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The Association of Thai Industries (ATI)	
Mr. Kavee Vasuvat	President, Automotive Assembly Industry Club
Mr. Ganok Bhongbhibhat	President, Iron and Steel Industries Club
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Mr. Pattana Jungrungreangkit	President, Thai Summit Auto Parts Industry Co. Ltd.

Annex 2(3)

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Dr. Boonwa Thampitakkul	Assistant Professor, Faculty of Engineering, Chulalongkorn University
Dr. Kovit Satawut	Assistant Professor, Faculty of Engineering, Chulalongkorn University
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Mr. Jean Raphael Chaponniere	Consultant
Mr. Karl Heinz Plaetzer	Consultant
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Mr. Franciscus Vlemings	Adviser on Iron and Steel Industry Restructuring (UNDP/UNIDO-NESDB Industrial Restructuring Project)
Mr. Eric J. Wightman	Adviser on Machinery Industry (UNDP/UNIDO-NESDB Industrial Restructuring Project)
Mr. Nils Ramm-Ericson	Senior Industrial Development Officer, Regional and Country Studies Branch, Division for Industrial Studies, UNIDO, Vienna
Mr. M.A. Siddiqui	Senior Industrial Development Field Adviser and Special Representative of the Executive Director of UNIDO to ESCAP, Bangkok
Mr. Tadashi Kondo	Assistant to SIDFA, Bangkok

Annex 3(1)

RESCOM-UNIDO
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LIST OF DOCUMENTS PRESENTED AT THE SEMINAR ON ENGINEERING INDUSTRIES IN THAILAND

Engineering industries in Thailand: An overview, prepared by the RESCOM Secretariat.

Current state of the metal and metal product industries, prepared by Rachin Chintayarangsan and Chaw Niamsorn.

Current state of the machinery industry, prepared by Kovit Satavuthi, Boonwa Thampitakkul and Rachain Chintayangsan.

Government procurement policy with special reference to engineering industry products, prepared by the RESCOM Secretariat.

Technology for the development of engineering industries in Thailand, prepared by Chatri Siripaipan.

Financing issues for engineering industry development of engineering industries in Thailand, prepared by the RESCOM Secretariat.

Strategy for developing versatile exports in manufacturing of engineering-based products, prepared by Eric J. Wightman, UNIDO Consultant.

The role of small industry in the engineering sector, prepared by Karl Heinz Plaetzer, UNIDO Consultant.

Recent international trends in engineering industries and issues for consideration in Thailand, prepared by IS/REG, UNIDO.

Demand for engineering products, prepared by IS/REG, UNIDO.

Some issues regarding product development and quality upgrading in Thai engineering industry, prepared by IS/REG, UNIDO.

Electronic industries in ASEAN countries and in the Republic of Korea, prepared by Raphael Chaponniere, UNIDO Consultant.

Annex 4(1)

RECENT INTERNATIONAL TRENDS IN ENGINEERING INDUSTRIES AND ISSUES FOR CONSIDERATION IN THAILAND[1/]

1. Trade and production of engineering sector

The engineering industry (EI) are defined to cover ISIC catetories 381-384 (production) and SITC group 7 (trade); the main susets of engneering industry include fabricated metal products, electrical and non-electrical machinery, and transport equipment.

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

Developing countries exports of engineering industries are, at $12 billion, less than 3 per cent 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.

Production figures (less up to date than trade) put world engineering industries output in 1980 at around $780 billion of which developing countries account for roughly 6 per cent. Despite rapid growth through the 1970s in larger developing countries (e.g. compound rates of 35 per cent per annum in the Republic of Korea, 13 per cent per annum 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 per cent more

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1/ Note prepared for the Seminar on Engineering Industries in Thailand by the Regional and Country Studies Branch, Division for Industrial Studies, UNIDO.

than Sweden. For countries in Asia, some impression of the weight of engineering industries in exports and production can be gained from 1981 figures (see Table 1).

Table 1. Machinery and transport equipment in production and exports of selected Asian countries, 1981

Production	% of manufacturing value added	% of total exports
Indonesia	7	1
Malaysia	18	12
Philippines	10	3
Republic of Korea	18	22
Singapore	55	22
Thailand	15	5

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

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

Later in this note, it is argued that engineering industry 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).

Annex 4(3)

Table 2. Some key data on the Swedish metal-working and engineering industry (ISIC 38)[1/]

	Metal products ISIC 381	Non-electrical machinery ISIC 382	Electrical machinery ISIC 383	Transport equpiment ISIC 384	Total %
Establishments	44	31	11	11	100
Employment	21	32	21	22	100
Capital stocks	26	40	13	21	100
Sales value	20	32	19	29	100
Investment 1974-80	23	32	20	25	100

1/ Excl. 385 and 3841 (shipyard).

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

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

a/ 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.

b/ 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 results shown in Table 4.

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	Meidum	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 proudction volumes and relatively standaridized; 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 developing countries 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 developing countries 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 potentially bring substantial benefits to local engineering industry 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 developing countries are in danger of suffering the adverse effects without organizing to keep the benefit.

2. Engineering industries

The crucial position of engineering industry 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 very 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).

Since at least the second half of the 1960s the question of devising and implementing policies for the development of domestic engineering capabilities in developing countries 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 the engineering industry, 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 developing countries 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 developing countries, 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 protectionst tariff 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 contracts 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 developing countries 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 developing countries, 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 engineering industry, 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 engineering industries. 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 internationalized 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 developing country markets.

These points are a mere sketch of some of the trends obervable. 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 suggests 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 particularly 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 valied 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 comments 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.

3. 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 requirments of technical knowledge regarding ci 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.

Annex 5(1)

ELECTRONICS INDUSTRY IN ASEAN COUNTRIES AND IN THE REPUBLIC OF KOREA[1/]

1. Electronics industry

Electronics industry is widely recognized as the major growth industry of the eighties with its influence permeating all means of industrial activities.

This industry is divided into three segments, namely consumer electroncis, industrial electronics, parts and components (microelectronics). Linked to these productions one can add software activity.

Microelectronics has been described as 'the crude oil of the new industrial revolution'. It is itself made up passive components (resistors, condensers...), and active which can be either discrete (diodes, transistor) or ranked according to the number of electronic components on a single chip: from small scale integration to very large scale (VLSI). In a 64K RAM memory or in a 16 bit microprocessor more than 100,000 components are packed in one chip.

Electronics industry combines high technology with labour intensive processes. Assembly operations are common in fabrication lines for consumer and industrial products. In microelectronics the early stages of silicon growing, mask making and wafer diffusion are highly capital intensive, whereas the latter stages such as assembly and testing are highly labour intensive. Many assembly lines are extremly complicated so that automation is a very onerous process in an industry characterized by high obsolescence rate. However automation does take place, either in consumer electronics or in microelectronics.

Contrary to consumer electronics, microelectronics is a highly concentrated sector. The top ten merchant semi-conductors suppliers produced

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1/ Note prepared for the Seminar on Engineering Industries in Thailand by Mr. Raphael Chaponniere, UNIDO consultant. Mr. Chaponniere is presently visiting fellow at the Institute of Southeast Asian Studies, Singapore.

55 per cent of world semi-conductor sales in 1983 (US $9.4 billions out of US $17.4 billions). High research and development costs, short product cycles favour large integrated firms with diversified product lines. The economic behaviour of microelectronics used to be quite similar to that of a commodity's, with fluctuations in prices and business cycles of three years periods. This is likely to change with the growth of specialized needs creating market segments of sufficient magnitude to attract several suppliers.

2. The development of electronics industry in ASEAN and in the Republic of Korea

From the earliest stages the growth of electronics in LDC countries has been affected by the production strategies of large Western and Japanese based companies.

In the consumer electronics industry virtually all ASEAN countries began to promote local production as a substitute for imports in the late fifties and early sixties. The erection of protective barriers compelled foreign exporters to launch local production in order to keep their market. The Republic of Korea was no exception and, like ASEAN countries, it was persuing an import substitution strategy.

During the late 60's and early 70's the growth of the electronics industry in these countries can no longer be explained by the growing domestic demand, but rather as a response to renewed economic priorities and opportunities.

Two sets of factors explain the rapid setting up of export oriented units producing electronics components:

- a "push" occured to a varying extent in these countries to meet new economic problems. The priority given to the electronics industry was regarded as a remedy for the growing problems of unemployment, or in others as a quick way to earn foreign exchange and to diversify the export mix.

- a "pull" occured which can be only explained in terms of the evolution of world's electronics industry. Competitive pressure from Japanese

imports motivated a number of American firms to defend their market by establishing offshore assembly operations. After the liberalization of capital exports Japanese competitors followed suit and began transferring some of their production units.

The surge in investments took place in a very short span of time, and in most of ASEAN countries it lost its initial momentum in the second half of the 70's; in the Republic of Korea domestic companies continued to invest and grow. Total direct employment created by these investments in ASEAN can be estimated at 140,000 (Table 1); more than 75 per cent was created before 1978. Between 1969 and 1978 160,000 employments were created in the Korean electronics industry; total employment was 183,000 in 1978, it declined later to 153,000. Exports, however, went on growing, and productivity growth alone explains this development.

Table 1. Role of the electronics industry in total manufacturing in ASEAN countries, 1982

	Indonesia	Malaysia	Philippines	Singapore	Thailand	ASEAN
Employment (No. of persons)	16,000	61,000	(25,000)	61,000	(15,000)	(178,000)
in % of total employment in manufacturing	(2.6)	(10)	(2.5)	(22)	(4)	
Value added in % of total MVA	1.6	(2.5)	...	15.6	...	

() = estimate.

Lately US recovery combined with the upturn of the 'electronics industrial cycle' have led to a new surge in foreign investment mainly concentrated in Singapore and Malaysia.

Contrary to popular belief low wages alone do not create comparative advantage. Difference in wages are insufficient to explain the investment pattern that has taken place in ASEAN countries. The two countries which have received the biggest share of foreign investment are Singapore and Malaysia where wages were and still are the highest in the region. Labour costs do not

account for more than 15 per cent in most of the industrial, consumer or components industries.

Among the factors that can explain the location investment decisions of foreign manufacturers, one can point out:

- the possibility of running expensive equipment round the clock in a strike free environment
- the inherent skills of manpower
- the infrastructural environment in terms of transport and telecommunications
- the industrial environment in terms of supporting firms (plastics, die casting, precision machinery..). This latter factor is now becoming crucial for the offshore production of new products such as micro computers and peripherical devices (keyboards, disc drives).

3. Electronics industry in ASEAN and in the Republic of Korea

Employment in ASEAN electronics industry is around 180,000, roughly comparable to the Korean electronics industry. On a country by country basis it plays an important role in Singapore and Malaysia, elsewhere its share of manufacturing employment is less than 2 per cent. Only in Singapore is electronics important in terms of value added, accounting for as much as 15,6 per cent.

Table 2. ASEAN electronics exports and imports, 1982

(in million US $)

	Indonesia	Malaysia	Philippines	Singapore	Thailand	ASEAN
Exports						
Industrial electronics	...	6	3	240	...	249
Consumer electronics	...	153	15	860	9	1,037
Components	75	1,375	914	983	335	3,680
Total electronics	75	1,534	929	2,063	344	4,965
% of total manufacturing exports	12	50	50	24	13	
Imports						
Total electronics	348	1,770	841	2,721	...	

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Electronics components are ain export item and together the ASEAN countries have exported close to l illions. Divisification away from components has taken place in Singap nd is slowly making progress in Malaysia.

In all countries electronics exports recorded a jump in 1983 (Table 3 shows Singapore exports in 1983). They should be even higher in 1984 with the continuing upturn of the electronics business cycle. This expansion is expected to slacken in 1986.

Table 3. Singapore electronics exports, 1983

Industrial electronics (%)	18.8
Consumer electronics (%)	30.7
Components (%)	50.5
Total	100.0
Total US $	3,050 million

In the Republic of Korea total output for 1983 electronics goods reached US $5,600 million, a 37 per cent increase over the previous year. The domestic market plays a much larger role than in ASEAN countries, and exports account for 60 per cent of total output.

Table 4. The Republic of Korea electronics industry, 1983

	Production	Exports
Industrial electronics (%)	17.0	14.5
Consumer electronics (%)	40.0	45.0
Components (%)	43.0	40.5
Total	100.0	100.0
Total US $ million	5,600	3,000

In most ASEAN countries export oriented electronics industries are either foreign subsidiaries or firms operating on a subcontracting arrangement. Singapore is no exception. In the electronic field Singaporean firms play a

marginal role. According to the 1982 Manufacturers Directory there was in electronics 114 foreign firms and 69 domestic firms, 51 of which employ less than 100 workers. Foreign subsidiaries account for around 90 per cent of total employment in the electronics sector. Their export share is probably higher.

Table 5. Foreign investment in electronics in Singapore

(Cumulated in US $ millions)

1971	1976	1981	1982
65	200	750	900

Lately an evolution is taking place. New incentives have been given by the government to local companies to invest in new technology projects: The Robin Group has set up the first disc drive plant with Microperiphericals, intraco has established a joint venture to make programable robots. Another group has invested in mask making; it is the first independant mask making unit outside Japan. For Singapore to acquire technology local companies have to venture into this field themselves.

The electronics industry in the Republic of Korea was developed in the form of an international subcontractor for foreign countries. Between 1967 and 1976 138 foreign investment projects have been implemented; since then their number has been diminishing:

Table 6. Foreign investment in electronics and electrical machinery in the Republic of Korea

	1967-1971	1972-1976	1977-1981	1982	1983	Total
Number	27	121	21	6	8	183
Total amount (US $ millions)	10.6	82.9	107.7	19.2	9.2	229.8

Source: Korea Exchange Bank.

Most of the products exported were either produced by foreign subsidiaries or exported under the buyer's brand name, designs and many parts and components were imported. However changes did take place. The share of wholly owned subsidiaries and joint ventures have fallen from three-fourths in 1971 to less than half in 1983. Foreign interest in offshore production has diminished, and domestic production has been rising.

The Electronics Industry Promotion Law and the Eight-Year Electronics Development Plan promulgated the policies by which it became a strategic export-oriented industry. Additional supporting measures were adopted throughout the 1970s. This government support which entailed large credit facilities, has given additional impetus to large Korean enterprisses which were either involved in electronics (like Samsung, Gold Star of the Lucky Group) or which have diversified their activities to electronics (such as Daewoo with its subsidiary Taihan, or lately Hyundai). These three conglomerates are now spearheading the Korean drive to high technology.

The strong government support has, however, focused on the larger companies. There are currently almost 900 firms in the electronics industry, more than half of which employ less than fifty workers and lack the research base necessary to keep abreast of new innovations. The average size of the Korean electronics firms is one-tenth of that in Japan and given the technological currents some of the smaller producers may not survive unless they enter in close subcontracting arrangements with the major corporations in the subsector.

4. Some issues

In a sense the initial setting up of an electronics industry in ASEAN countries and in the Republic of Korea was "accidental". These countries have now gained a foothold in this most dynamic industry. Electronics has now gained additional priority because most countries recognize its technological importance and want to take advantage of the technological spin-off that electronics can offer. However, the new priority which is now given to electronics raises some issues:

- Electronics industry is often a technological enclave; hoping for technical spin-off is perhaps a wishful thinking;

- Without backward linkages export-orientation is bound to produce little value added;

- Will economic progress in electronics kill electronics industry in developing countries, and will foreign firms locate, "back to North" their subsidiaries?

There are no clearcut responses to these questions which have to be answered on a country to country and case to case basis.

(a) Is electronics industry doomed to be a technological enclave?

In most ASEAN countries the electronics industry consists of two, often unrelated subsystems, one catering for the local market of consumer goods, the other engaged in the exports market. The former is generally made up of large companies, either local or joint ventures and includes several small scale industries and some supporting industries. The latter usually comprises subsidiaries of foreign firms. In ASEAN countries, these two subsystems are frequently unrelated.

Almost non-existent in the early 1970s in Singapore, supporting industries have been growing steadily with financial support from the Economic Development Board and some assistance from multinational firms. These industries which cater for the needs of firms wholly engaged in electronics, produce plastics parts and engage in die casting of components and the production of precision mechanical parts. In 1981 these firms employed 12,000 workers, one-fifth of the number of persons engaged by the electronics industry. The existence of dynamic supporting industries is a new incentive for foreign investors. Singapore has now an edge on Hong Kong and the Republic of Korea in disc drives because the latter two, strong in electronics components, are relatively weak in precision mechanical parts and machining industry.

Indeed, electronics industry is not as "industrializing" an industry as mechanical engineering. However, it is not unrelated with other industrial

sectors. It can offer new outlets for industries in other fields and can help upgrading their technology: its technical requirements in terms of quality and precision are usually high. Having fulfilled the special needs of electronics firms, supporting industries can diversify their market.

There is no economic constraint which can prevent the building up of a supporting sector. A time comes when the electronics industry reaches a critical mass and a "subculture" of companies can emerge in order to serve the larger firms with components and other subcontracting facilities. The electronics industry is not doomed to remain an enclave in the domestic economy. Recent investment decisions in Malaysia and Thailand can be advocated. In Penang, Atlas Industries will produce magnetic computer heads and disc drives, and to support its production the US firm will invest in metal stamping, die casting and plating. In Thailand, NMB is starting production of computer keyboards and miniature ball bearings.

(b) Export-orientation and backward linkages

Economic literature tends to dichotomize export promotion and import substitution as if they represented mutually exclusive types of industrial development. In ASEAN countries export promotion is often associated with the creation of export processing zones and export-oriented electronics industry. Exports consist of electronics components, domestic value added remains minimal.

Evidences from Singapore and the Republic of Korea show that other evolutions can take place.

Backward integration has been implemented by foreign firms in Singapore, and one can speak of a "virtuous circle" to describe the evolution that has taken place in Singapore.

Singapore has become one of the biggest exporters of radios and TV. This has attracted part makers: Singapore is now the only place in ASEAN where one can find a cathode ray production unit. This component is most important in

terms of price and its production cannot be economically justified for an output below one million tubes per year.

In microelectronics backward integration began in Singapore with the setting up of testing facilities for components produced in Singapore or elsewhere. It went on with the investment by SGS/ATES in wafer fabrication, the very heavy, capital and technology intensive "front end" of semi-conductor manufacture, and goes further with the recent announcement of new investment in integrated circuit design made by Fairchild and Honeywell Synertek.

Upstream linkages are not limited to production facilities. They also concern research and development. Such activities need to entertain tight technical relations with the production shop. This has led some audio firms to set up their R and D in Singapore. Seagate a major disk drive manufacturer has also decided to invest in R and D in Singapore which has become one of the world largest disc drive exporters.

In the Republic of Korea foreign firms do not play such an important role. Backward integration is carried on by private domestic firms responding to the government incentives.

Describing the Korean industrial strategy as export-oriented is misleading. One should speak instead of backward linkages import substitution fuelled by export competitiveness. This is clearly the case in the electronics industry.

The four largest TV manufacturers acquired their technology through licensing agreements from major Japanese and European producers; the technological "package" comprised technical know-how, products specifications, technical assistance. Most of the components were imported. The government incentives policy has actively promoted an import substitution strategy of parts and components, TV manufacturers have either integrated these productions or assisted local firms to do so. In 1965, 30 per cent of the components were locally produced, ten years later this ratio stood at 90 per cent.

Upstream integration has already taken place in the Republic of Korea in microelectronics; wafer fabrication began in 1975. To date the industry efforts have been concentrated on lower ends integrated circuit for TV and audio equipment. Samsung bought the 4 bit license production from Sharp (used for TV sets, micro oven); Gold Star obtained the 8 bit from Zilog (used in micro computer such as Apple compatible). In its drive towards high technology Korean groups, backed by the government, want to leapfrog lower generation memory chips and be early participants in 64K memory and 256K DRAM memory where markets are large and set standards still only starting to develop. It is thought that experiences gained in this field could be used to develop custom chips for which a booming market is widely predicted over the next few years. Such a move would necessitate research and design capacities which are in short supply.

(c) Relocation back to the North?

The application of microelectronics is likely to change the established modes of production considerably. This evolution has given ground for a 'relocation back to the North theory' hypotethis.

To date there is no clear cut evidence of such an evolution as shown from foreign investment figures in either Malaysia or Singapore. The current world electronics boom has been felt in all ASEAN countries, even in the Philippines where facilities' extensions have been going on. Moreover, one can discuss the rationale of such a theory. As pointed out earlier, low wages are hardly the only comparative advantage. The possibility of running expensive equipment round the clock in a strike free environment is also a powerful incentive; it will hardly be diminished by the use of more expensive equipment.

However, and probably of greater significance for the future there is a perceptible decline in the rate of value added to production cost. This is a reflection of changes in the economics of integrated circuits production; investment in highly sophisticated equipment could accelerate this trend. In Singapore the share of value added to output has declined from 32 per cent in 1975 to 20 per cent lately in electronics components production, and from 27.5 per cent to 25 per cent in consumer goods industries.

There are at least two remedies to this decline in value added: upstream integration and product diversification.

In the long-term, and beyond the probably inescapable future downturn in business activities, market orientation will remain the single most decisive determinant of business location patterns in the semi conductor industry and in the electronics industry as a whole. All stages of production, from design to production tend to be located near the area of market growth, and ASEAN countries represent one of the main growth markets.

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Annex 6(1)

THE ROLE OF SMALL INDUSTRY IN THE ENGINEERING SECTOR[1/]

1. Introductory remarks

The development of small-scale industries of the engineering industry sector directly contributes to one of the four objectives set forth in the Fifth Five-Year Development Plan of the Royal Thai Government for industrial restructuring, namely

- to increase the proportion of value added of small-scale industries[2/].

The engineering industries play a predominant role in achieving this objective as their share, both in developing countries and in industrialized countries, in the number of enterprises is above 95 per cent and in employment around 50 per cent, and is higher than in the overall industrial average. Yet as far as employment figures in the small industries in the engineering industry sector are concerned, it is expected that the downward trend in total number of employees will continue in the near future as well as the shift from unskilled or manually skilled labour towards employees with higher degrees of education and specialized training. This trend will most certainly be earlier noticeable in industrilized countries where it will also most probably have greater effect than in developing countries simply because of the higher degree of industrialization.

The definition of small industry varies from country to country. In Thailand two categories of enterprises should be considered when discussing small industry matters:

1/ Paper prepared for the Seminar on Engineering Industries in Thailand by Mr. Karl Heinz Plaetzer, UNIDO consultant.

2/ The contribution to the three other objectives (i.e. to increase the proportion of value added of manufactured exports from 16 per cent to 25 per cent in 5 years; to begin the process of national import substitution of intermediate products and to develop resource-based industries; and to increase the proportion of manufacturing value added in areas outside Bangkok and in nearby provinces) is less predominant than to the one mentioned above.

- Small scale or cottage industries employing up to 10 persons including the owner who normally is actively engaged in his enterprise; and
- small scale industries with from 11 up to 50 employees.

Enterprises with from 51 to 200 employees are considered medium size industries, and those employing more than 200 people are large industries.

In other countries e.g. Latin American countries, apart from different numbers of employees to classify the enterprises, sometimes additional criteria are employed like fixed investment per employee (which is normally around up to US $3.500 in cottage industries but sometimes as little as US $1,000 or even below, and goes up to US $10,000 in small industry), or total fixed investment (e.g. US $100,000 per enterprise). It is noteworthy that most Latin American countries are using an additional form of distinction: cottage and small-scale enterprises belonging to the formal sector and those belonging to the informal sector. The informal sector generally consists of enterprises without legal registration which neither pay taxes nor social security contributions for their workers. Yet these enterprises contribute considerably to employment generation, especially in the metal working sector, showing in some countries upward employment trends even during the recent recession period when overall industrial employment declined. Some countries have developed specific technical assistance programmes for the development of these informal enterprises which eventually might lead some of them to legalize their status. Various of these programmes are executed with foreign technical assistance and special credit facilities, mainly through the Inter-American Development Bank.

2. Areas of activity of small scale industries of the engineering industry sector

(a) Product scope

The huge dimensions of the engineering industry, the great variety of products manufactured by it and the different structures of market outlets require a differentiated approach on a subsectoral, product level or industry

structure level. The following grouping of main areas of activities of small scale engineering industries is intended to assist in structuring the planning and promotion activities in Thailand.

The engineering industry sector can be subdivided into two major groups:

- capital goods and
- consumer durables

In general terms, production of consumer durables is technologically less complex and is for various reasons more advanced in developing countries than production of capital goods.

Production output of the engineeing industries can be classified into end products and intermediate products, components and parts. In the industrialized countries the small enterprises concentrate on the production of intermediate products while in developing countries there is a considerable number of small enterprises manufactujring end products. This indicates that specification of production, concentration of efforts on specific engineeing tasks and subcontracting and complementation are in their primary stages in the developing countries. It can be expected that in the course of time some of the small scale industries manufacturing end products will grow into medium or big size enterprises, maybe also through merging with competitors, others will switch to specialized production, mainly components and parts, and others will disappear as they are not able to cope with their competitors and lack the flexibility to readjust to the new market environment.

Intermediate products should be considered to be capital goods even though they have a special position. These intermediate products will in steps of further processing or assembling become part of either a consumer durable product (e.g. electric motors built into household appliances) or a capital goods product (e.g. electrical motors in a current factory).

(b) Replacement parts production

An activity relatively pronounced in developing countries yet hardly encountered in industrialized countries is the production of spare-parts, mainly in small scale or cottage industries. In industrialized countries the

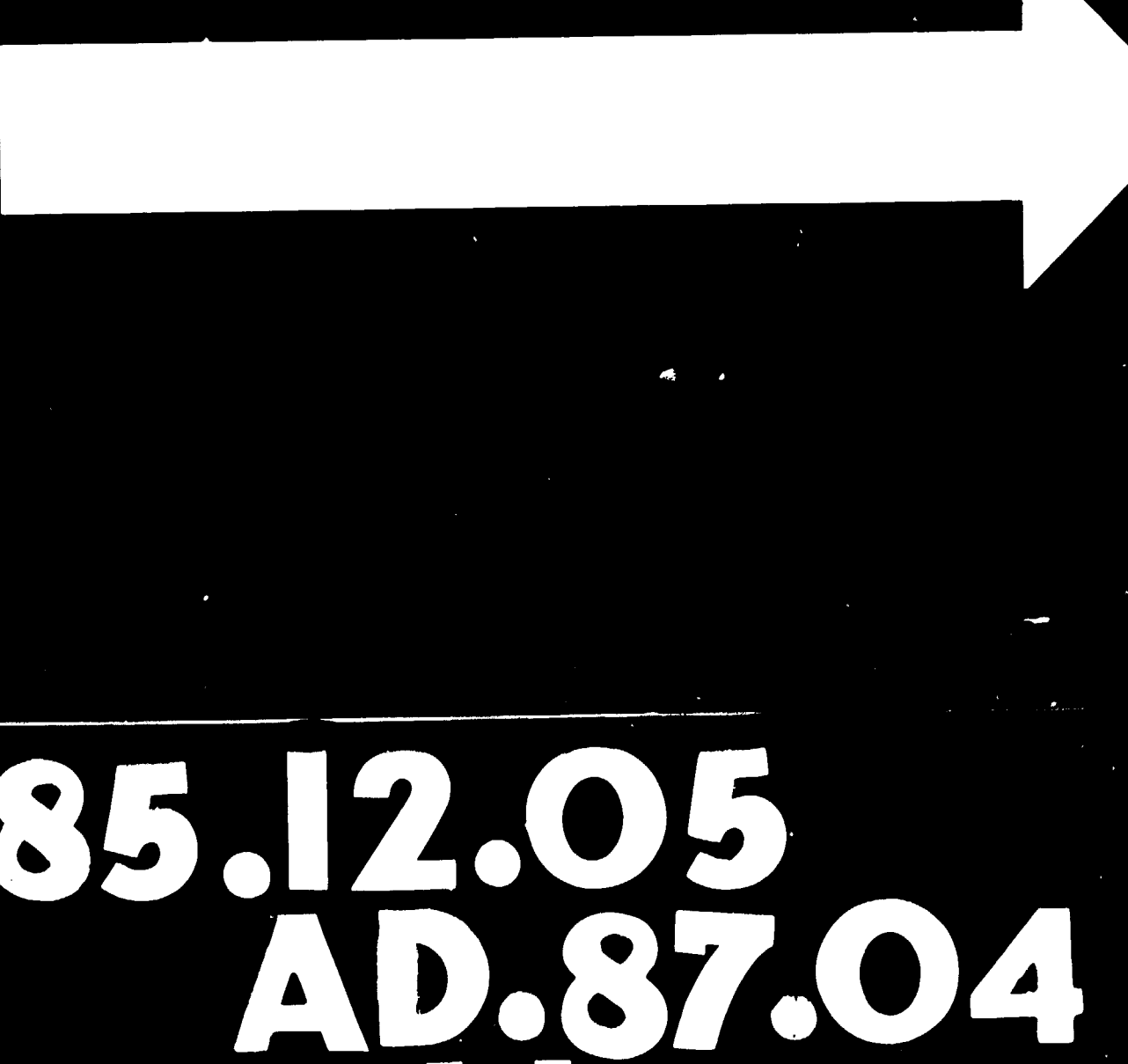
manufacturer producing parts and components normally operates under a subcontracting scheme not knowing whether a particular product is used as replacement or as component of a new end product. In developing countries it is quite common that small scale industries produce similar parts in small quantities normally on a job order basis yet only for replacement. This holds especially for the capital goods sector where there is no domestic production existing (e.g. parts for processing factories in the chemistry, mining, cement or food industry). In some cases these small scale industries are potential suppliers of components once local manufacturing of the corresponding equipment into which the component is built in is taken up.

(c) Repair and equipment maintenance

Besides manufacturing typical activities of small scale engineering industries are repair and maintenance of machinery and equipment. While repair activities are very common in developing countries and represent sometimes the only source of income for a small scale industry, especially those in depressed urban districts, maintenance service of machinery and equipment is not yet an activity worthwhile to mention. Maintenance is either not undertaken by the user or done by himself or the sales company (importer) having delivered the equipment. Yet in industrialized countries there is a considerable number of enterprises specialized in equipment maintenance working under service contracts with the equipment users.

(d) Sales market structure

As mentioned above, the majority of small scale engineering industries in industrialized countries operate on subcontracting basis for, in general, several customers. The customers, on the other side, have normally several supply sources for the same product. This means that both sides try to avoid monopoly situations. In the case of end products manufacturing by small industry, marketing through established distribution channels is predominant unless the product is highly specialized and demanded by a limited number of customers. In this case, direct sales are commonly chosen.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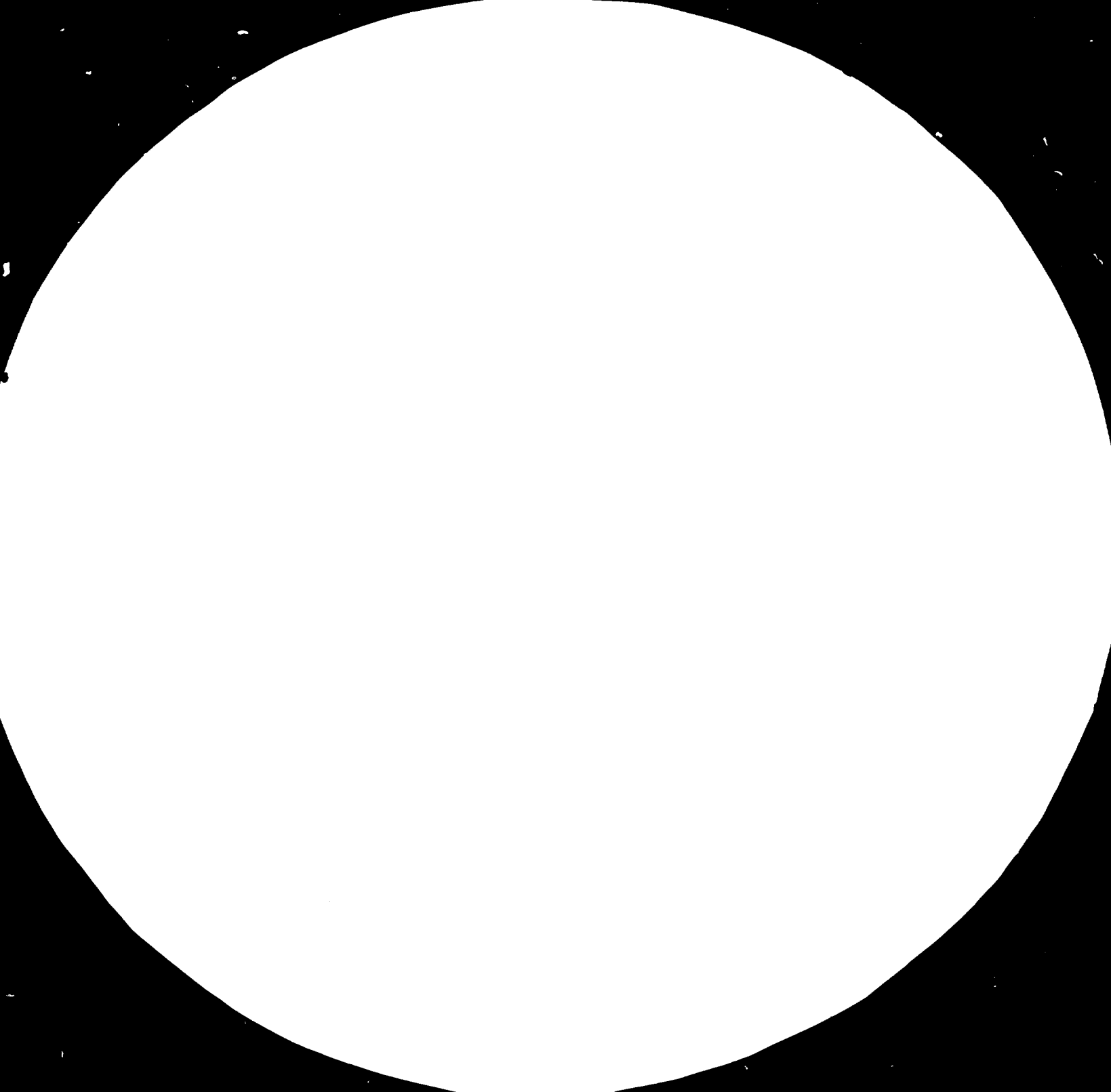

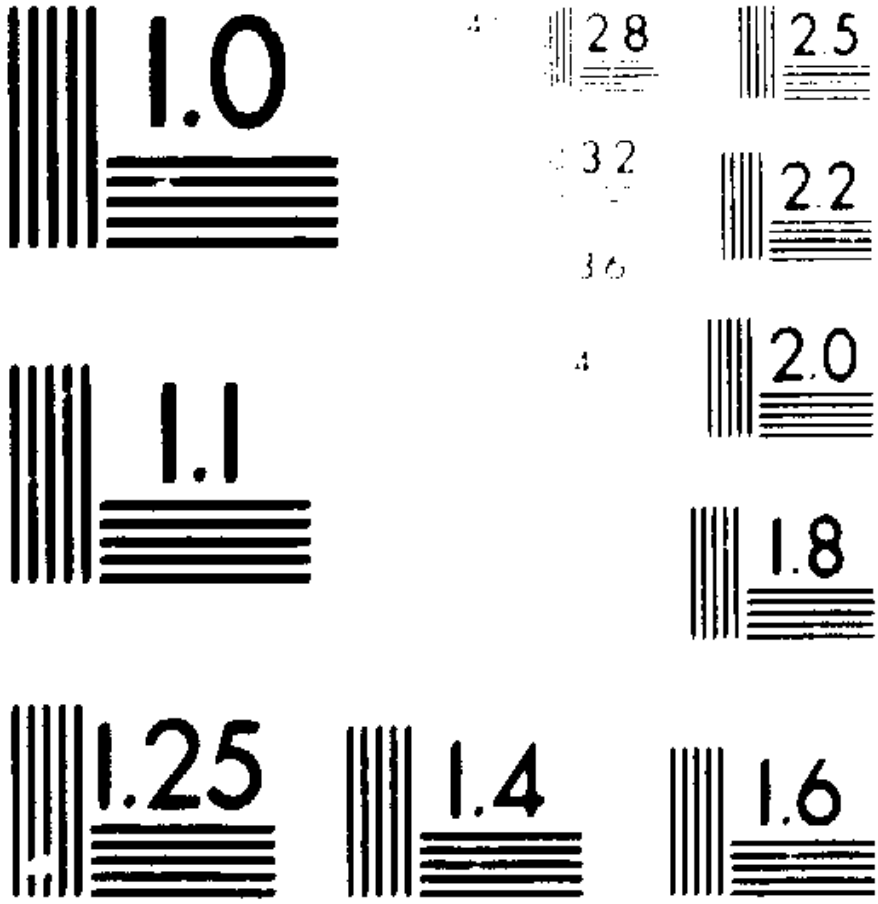

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Marketing differs considerably between small scale industries in industrialized and developing countries. It is given much more attention by the entrepreneurs in industrialized countries, especially sales promotion (catalogues, product descriptions) is much wider applied. The efforts of the enterprises are often complemented by those of associations or by special governmental small industry development agencies. In some countries (e.g. USA) government purchases can require that the supplier subcontracts considerable parts of his contract volume to small industries.

As a whole, the sales market structure for engineering industry goods is less advanced in developing countries. Direct sales are predominant, subcontracting or complementing systems are in mostly primary stages, and the markets are hardly transparent, neither the sales market for the supplier nor the supply market for the customer. This is especially the case for parts and components.

(d) Demand sectors

Market developments and growth potentials of specific subsectors or groups of products of the engineering industry sector vary considerably from country to country even though some general data can be established (e.g. share of engineering industries in manufacturing value added at various stages of per capita income). To estimate market prospects and orders of magnitude of production or sales potential it is necessary to analyze the economic sectors with demand potential. For consumer durables this means a market analysis including population and income growth, consumer behaviour at various stages of income etc.; for capital goods this means an analysis of the realistic growth potential of the respective demand sectors (e.g. fertilizers, other petrochemicals, cement, pulp and paper, textiles, food industry, user sectors and subsectors of machine tools, office machinery, construction, communication, electricity etc.).

The demand sector analyses and their comparisons will clearly indicate the growth potential of the corresponding engineering industry. This applies specially for the capital goods sector. These analyses will also be

fundamental to determine the future role of cottage and small scale engineering industry as a subcontractor for parts and components.

3. Trends in technology in the engineering industry sector

Production characteristics are, since approximately 18 years, undergoing considerable changes. The application of numerical control of machine tools brought about the mass production of machined products reducing the labour force required on the shop floor and the potential of human failure in machining. Following came the automation of plant operations around the production process, specially in automated quality inspection and raw materials, and intermediate products and finished products warehousing. More or less parallel to that a reshifting in machining operations started by introducing multifunctional machining centres with automatic changes of tools and three-dimensional working capacity. Their introduction reduced the minimum lot sizes and increased the flexibility of production besides also reducing the labour force required. During the introduction of these machining centres the automated materials handling or industrial robots were introduced in the automotive and other industries, again reducing labour requirements on the shop floor.

Technological changes which are about to be massively applied, after having gone through several years of development and testing, are computer aided design (CAD) and computer aided manufacturing (CAM). Similar as the previous technologial changes they indicate the growing importance for the economic viability of the engineering industry, small, medium or large scale, of results of planning efforts resulting in improved machinery, equipment and operations and reducing human intervention in the production process. These efforts belong to what sometimes is called 'intangibles'.

Intangible in this context can be described as investment in planning, organization and human resources which cannot be quantified until activated at a later stage of business operation. In other words, intangibles represent investment in technology. They most probably will affect the small engineering industry in two aspects: First, they will require a flexible

response by the entrepreneurs to the changing production environment so that his business profits remain unaffected (this aspect will have more importance in industrialized countries with well developed small engineering industries and might have less effect on the majority of small scale industry in developing countries with traditional low price and relatively low quality products); second, they will represent additional business opportunities for cottage and small scale enterprises, yet of a different type than commonly known up to now in the developing countries.

The group of intangibles of major importance to the development of engineering industries are:

- operational planning
- engineering design
- product design
- manufacturing software

For each of the cases computerized operations are characteristic. Operational planning refers to the sequence of overall functions of the enterprise, i.e. timing of production input, purchases, production planning, stock control, dispatching etc. In engineering design of complete processing plants computerized systems find already widespread applications. These aides might in the future facilitate the setting up of specialized engineering companies with or without production capacity for specific products, e.g. in food processing, chemicals or heavy equipment manufacturing.

Product design and manufacturing software will most certainly be of great importance towards the end of the decade for the small scale industry in general. Computer aided design (CAD) and computer aided manufacturing (CAM) will, together with the change to machining centres presently taking place in industrialized countries and already starting in Thailand (two cases are reported, one foundry and machining company and one company making components for transmission gears), alter the production potential of small industry completely:

- CAD will reduce the drafting time and cost for parts and components (in the American automotive industry reductions in time required from 2 years to 6 weeks have been reported);

- the installation of machining centres and CAM will reduce the minimum lot size per unit output so that small market sizes are less of an obstacle to take up production;

- CAD and CAM reduce the potential of human failure to a minimum, especially failures due to false machine operation are eliminated;

- CAD and CAM will allow developing countries to produce products of international quality standards;

- CAD and CAM will reduce the implementation time for taking up new products or product lines in manufacturing, start-up losses are also reduced;

- CAD and CAM will have a negative effect on employment of unskilled or low skilled workers but will create a strong demand of highly educated personnel in informatics and engineering.

The described group of intangibles, especially CAD and CAM, will have a major impact on the development of the engineering industries in the developing countres. Besides the traditional small scale engineering industries with technologically relatively simple products, a new type of small scale production industry will emerge: highly automated flexibly operating enterprises opening new manufacturing potentials of technologically complex products at international standards of quality. Basically the minimum size of enterprise to be set up is determined by one machining centre. However, it is desirable to install two machining centres to increase operation flexibility. Total investment costs in machinery and basic CAM hard and software of a minimum size plant are around US $80,000 for one and US $120,000 for two machining centres, and employment created is in the order of 9 to 14 persons (including office and warehousing/dispatch personnel, and of which 3 to 4 persons are on the shop floor).

The growth potential for the value added of the engineering industry can rise considerably, yet the effect on employment will be limited, even though it is extremely positive for highly educated young professionals (university or college graduates). Yet due to the reduced start-up time for new products or product lines the annual growth of employment over a limited period of time might be as high as previously experienced in nearly industrialized countries when computer application were less advanced.

Apart from new production enterprises other new types of small scale industries will also have good market potentials:

- engineering companies for planning and commissioning of process plants; and
- companies producing the software required by the production enterprises and other users of computers.

In other cases it is most probable that in the beginning of operations the companies described above for taking up new production lines will be closely related to the engineering industries, would however belong to ISIC group No. 832.[1/] It can be assumed, just to indicate an order of magnitude, that for each lot of 6 production companies one software company employing 6 persons will be established. Investment in these companies is limited to microcomputers, peripheral equipment and office equipment.

Apart from these job creations the employment opportunties for CAD should be taken into account. An outline of a possible organizational framework for CAD is presented in Chapter 5(c).

4. Basic criteria for development of small scale engineering industry

(a) Structural aspects

The technological change described above will in the future cause the existence of two classes of small scale engineering industries:

- the traditional, labour-intensive (on workers' level) enterprise manufacturing relatively low priced products of low technological complexity and low quality standards; and
- the modern, more capital intensive and less labour intensive (yet labour incentive regarding high educational level, college and university graduates), technologically advanced and flexibly operating enterprise using machine centres and CAD services, applying CAM and manufacturing products of international quality standards.

1/ Business services except machinery and equipment rentals and leasing, of which ISIC 8323 is "Data processing and tabulating services". (The provision of data processing and tabulating services of a general character, on a fee or contract basis.)

Both classes of small scale engineering industry have different sales market conditions and will require different marketing efforts, besides their completly different plant operations and machinery and equipment. This will demand for an entirely different promotional approach: while the first class will need technical assistance to improve their economic and technical status, the second class requires mainly pre-investment guidance and an environment in legal, fiscal and business servicing matters which will direct human resources and venture capital towards the creation of these new engineering industries. This also is valid for the setting up of service companies for computer hardware and small software generating enterprises.

(b) Criteria for the promotion of traditional small scale engineering industries

Traditional small scale or cottage engineering industries are normally started, as shown by the experience of various developing countries, by people having entrepreneurial spirit and a basic technical knowledge in the field they are engaged in, capital is only scarcely available. The small scale or cottage industry then develops according to the entrepreneurial capabilities of the owner. It is relatively common experience that the major obstacle of growing to a larger scale operation are the lack of knowledge in business administration, external financing, accounting and cost calculation. After overcoming these obstacles and growing to a bigger size company (one can assume that at this stage it enters the range of small scale engineering industry) the shortcomings start to b in marketing, allocation of funds and improvements in production technology, especially product quality for which access to technology, technical assistance and/or training is normally needed. In very general terms the enterprises created directly as small scale industry encounter the same problems for continuing their growth.

As criteria for promotion can be deducted broadly:

(i) Traditional small scale or cottage industry

- Assistance in business administration, financial planning (including elaboration of documentation for obtaining bank credits), fiscal matters and production technology (e.g. plant layout, use of tools and fixtures);

- Introduction of accounting, cost calculation and sales price fixing procedures;

- Training courses in microeconomic (administration, accounting cost calculation, pricing, marketing, financing etc.) and technical areas (plant operation, construction and design, machining, maintenance etc.);

- Special technical services information, construction, design and product development services, special production service centres).

(ii) Traditional small scale industry

- Advanced activities in all areas mentioned under traditional cottage industries;

- Access to technology through technology transfer;

- Promotion of subcontracting and complementation;

- Courses and assistance on selection of appropriate machinery, tools and fixtures, product standards and quality control;

- Support to the creation of associations and marketing efforts (e.g. fairs, edition of buyers' guides).

A possible institutional framework for the implementation of these development measures will be presented in Chapter V.

(c) Criteria for the promotion of modern small scale engineering industries

As mentioned above, enterpreneurs and/or their key managing personnel of modern small scale engineering industries will have a high level of education in informatics and engineering. It is assumed that they are able to solve their business problems either themselves or by addressing themselves to the right source for the solution (e.g. software companies, market research agencies, technology transfer sources, CAD-suppliers). The enterprises themselves will have relatively little need for assistance and training courses of the kind as described in the previous section.

However, the basic requirements are in the area of:

- human resources development or investment in technology;
- creation of appropriate business environment;
- support activities for business development; and
- information on technological advancement of the machine industry, computer industry and software developments.

To meet these requirements a major scale co-ordinated approach based on detailed preliminary planning will be required which will be outlined in the following chapter.

5. Promotion of small scale engineering industry

(a) Determination of demand sectors

The traditional cottage and small scale industry, as far as they manufacture low price and low quality products, will according to international experience have only a marginal chance of growth in the future. In the long-term, customers will require higher quality products so that the low price products will most probably gradually encounter reduced market outlets. However, a good deal of the existing companies should be able to grow into higher product ranges if the right assistance is granted to them. The importance of these companies for employment also require their assistance.

For the engineering industry sector in general it is recommendable to establish a strategy for its development. Experience of industrializing countries have shown that it is advisable to concentrate efforts on those engineering industries whose demand sectors experience outstanding rates of growth. These can be determined by so called demand sector analyses (see paragraph 2 (e)).

Subsequently the possible role of small scale industry has to be established by international comparison of production and subcontracting patterns. After that, a promotion strategy on a product or product group basis can be developed followed by the elaboration of investment opportunities

studies with the objective to raise the interest of private investors. It should be analyzed whether a special task force at an investment promotion or financing agency should be set up to take over this objective.

(b) Institutional framework for the traditional enterprises

Many developing countries have set up specific institutions or departments within industrial promotion agencies and/or development banks for small scale industries. The experience shows that the operation of these promotion units is relatively costly so that a direct profitability can hardly be achieved. A social cost/benefit analysis would give more insight but, unfortunately, rarely is arried out. However, the social importance of small industry, both for employment and entrepreneurship development, are additional criteria for their active support along the criteria set forth in paragraph (b).

(c) Organizational framework and promotional scheme for modern enterprises

In accordance with paragraph 4(c) an organizational framework will have to be established for human resources development used here synonymously for investment in technology. Based on a thorough analysis of the Thai educational, public and industrial environment a key project, prefereably executed in one institution concentrating on the objective of introducing CAD/CAM systems should be launched. It is desirable from an outsider's point of view, to link it with a university and establish it at post-graduate level. To avoid start-up delays and an overloading with adminstrative and clerical work and co-ordinating delays it should not be started as a new institution or agency. A close contact between the project, industry and government is recommended. The project supervising committee will have to set clear objectives to project management in subjects and time and will have to exercise close control on its achievement, while the management will have responsibility for selecting the right procedures and means to meet the objectives in time.

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As relates to the creation of appropriate business environment measures to be implemented after thorough analysis of the Thai environment may include among others

- fiscal incentives (e.g. elimination of import duties on raw materials and of business tax as an obstacle to subcontracting);
- investment incentives, especially preferential and time saving treatment for obtaining investment and production licenses;
- legal regulations (.e.g. on subcontracting);1/
- market information, especially on export potentials, through public agencies;
- promotion of industry associations and continuous information exchange between industry and public authorities;
- technical support (e.g. standardization of parts);
- infrastructural support (industrial land, access, communication);
- training courses for machine operating personnel.

Some of these measures will also play an important role among the support activities for continuous business development. These support activities should concentrate on:

- active interchange between the CAD/CAM key project and the manufacturing industry;
- development of new products applying CAD which should be offered to the manufacturing industry at determined prices,2/ if applicable in co-operation with other R and D agencies;

1/ In the USA, for example, there exist several laws promoting or protecting small industry as a subcontractor, e.g. the "Small Business Act" (1942) or "Payment of Subcontractors Law" (1956); since 1962 government contractors are required to inform on their subcontracting plans when presenting their tender documents if the contract volume exceeds US $500,000.

2/ Fixed, for example, as a percentage of expected sales value over three to five years; this amount could then be given as a credit by a bank to the enterprise which in turn wouldpay in cash to the CAD project.

- extension of standardization;
- consideration of the enterprises in government purchasing contracts;
- government contracts to software companies on software development;
- use of CAD-facilities by public authorities;
- promotion of additional investment through elaboration of investment opportunity studies; and
- continuous governmental/institutional marketing and export support (e.g. participation in international fairs, publication of buyers' guides).

For the information on technological advancement of the machine tools industry, computer industry and software developments the organizational or institutional framework for CAD seems the most appropriate nucleus. Most certainly the structures outlined for the promotion of modern engineering industries and the implicit technological advancement will require to be adapted to the Thai environment. This should be the objective of following measures of implementing a modern small-scale engineering industry.

Annex 7(1)

STRATEGY FOR DEVELOPING VERSATILE EXPORTS IN MANUFACTURING OF ENGINEERING-BASED PRODUCTS[1/]

1. Objectives

The problems impeding the growth of profitable exports from Thailand have been well documented. The broad objectives remain:

1. Reduce imports in the engineering sector by creating a sound local manufacturing base backed up by high technology product support.

2. Increase revenue by competing and exporting into world markets.

To which we may add that these objectives are against an increasingly competitive background in technological advance, from materials to microchips and engines to electricity generation.

I should like to quote Dr. B.R. Rola, ESCAP/UNCTC Joint Unit on Transnational Co-operations, who said at the Thammasat University Conference on Multinationals in Pattaya in July 1984:

> "the problem of technical development is somewhat like the character in Alice in Wonderland who complained that one had to run fast just to stay in one place."

That qutotation may sum up the main constraint very well.

2. Statement of the problem

To bring about any significant change in the engineering sector would require a simultaneous attack on four fronts:

1. Establishment of a world wide market intelligence organization to identify new market opportunities and who is doing what about them, where.

2. Supply low cost capital to invest in several key strategic national projects.

1/ Paper prepared for the Seminar on Engineering Industry in Thailand by Mr. Eric J. Wightman, UNIDO consultant.

3. Create an effective organization for continuously up-dating the technological input to existing designs and to develop new ones.

4. Reduce the cost of the supply of all raw materials which require to be either imported in a finished state or raw state.

In the case of (4) the problem is blurred by import duty, vested foreign interests and the fact that certain specialized raw materials are only obtainable from a limited number of suppliers. The Government is known to be continuously working on the problems.

Thus the areas which can respond to short- and medium-term changes in strategy are (1), (2) and (3) being the most likely areas we can do something about to effect an improvement in the balance of payments. Before discussing the detailed strategy for exporting, three questions should be asked:

1. How can the engineering industry serve the existing industrial sector in Thailand?

2. How can the engineering industry serve as a foreign exchange earner?

3. How can the engineering industry pave the way for further industrial development in a non-industrial country?

Firstly therefore, how can the engineering industry serve the existing industrial sector in Thailand? How can technology for expansion be transferred and then infused into industry, and how can we then sustain development? We know that at the present moment in time there are very few foreign license deals which allow this kind of transfer of technology, because they are limited to products only. We therefore need to go back to the beginning of a typical product life cycle and chart the course of technology transfer through to production and sales, see what we are lacking and ask what can be done about it, without spending a fortune in the process.

3. The role of the engineering sector

Let us briefly review what constitutes the engineering sector and highlight how the sector influences industry as a whole. The engineering sector manifests its identity in different physical ways by means of product

groups such as engines, agricultural machinery and electrical equipment. The main issue to bear in mind, however, when considering technological growth, are not necessarily the economists' interpretation of physical manifestions that are visible in terms of products but the multi-disciplined scientific ones such as metallurgy, mechanical design, electrical design, electronics, computing techniques and automation on which they are based. Technological advances are made in the scientific areas first, then applied to products, although there are many examples where the search for cost reduction has motivated the research. There is a second important point to make here - the blend of scientific disciplines between, say, purely mechanical product to eventual purely solid state microprocessor product - the well known analogy between the Abacus and pocket calculator - is very much the work of the multi-disciplined technical entrepreneur.

Thus any policy for furthering technological transfer or growth requires implementation through specialists in technological (or scientific) disciplines as distinct from products, to have any long-term future. The dangers of relying on imported technology through the medium of kits of parts which are only assembled locally cannot be over emphasized.

The development of technology tends to be a young man's world. Market opportunities may be either created because of predictions by research teams who can foresee technological advances, or by entrepreneurs who will grasp the technology of one industry and apply it to another. Application of aerospace control systems to machine tools for example. The linking of technology across several industries is thus a fundamental measure of the effectiveness of money invested in human and material resources.

4. Experience in the Western world

In the Western educational world today the universities are becoming much more practical minded and work more closely with industry for students wishing to take higher degrees. In England for example, most universities have 'science parks' attached, funded by banks, local authorities and industry, to enable new companies to be formed in high technology, with graduates from

universities. In USA there is the famous MIT (Massachusetts Institute of Technology) which was probably the first in the world to develop this theme.

Thus examples of the importance of the role of the university already exist for us to work from.

How do we now bridge the gap between universities and industry? Most manufacturing in the engineering sector in Thailand is small scale industry based, with few technically trained staff (with the exception of joint ventures relying on foreign capital and know-how). On the face of it there seem to be massive obstacles or shortages of financial, engineering and trained human resources which will prevent any short-term change to the situation, if we were to follow the product strategy of existing companies who normally only wish to sell last year's technology. So we won't follow the traditional road. Let us go back to the beginning again, looking to the universities and science parks of Western countries, operating in a 'green field' environment. These were encouraged by the banks and local authorities, (not normally generous when it comes to handing out cash) because of examples set by small entrepreneural companies, consisting of only a handful of engineers, who demonstrated that in a space of time of only two or three years they could generate multi-million dollar companies and topple international giants in their own market. Can we demonstrate similar flair for technological growth in the engineering sector in Thailand?

5. Building a bridge between universities and the engineering sector

What we seem to need is a bridging operation between universities on the one hand and manufacturing companies on the other. There is a strong case for setting up a Manufacturing Centre of Technology which in effect would be an advanced manufacturing pilot plant for rapidly converting new products to production, to illustrate the viability of new and improved products and processes. It would thus enable existing small scale industries to see what opportunities exist and exploit them. Figure 1 illustrates how this may be implemented.

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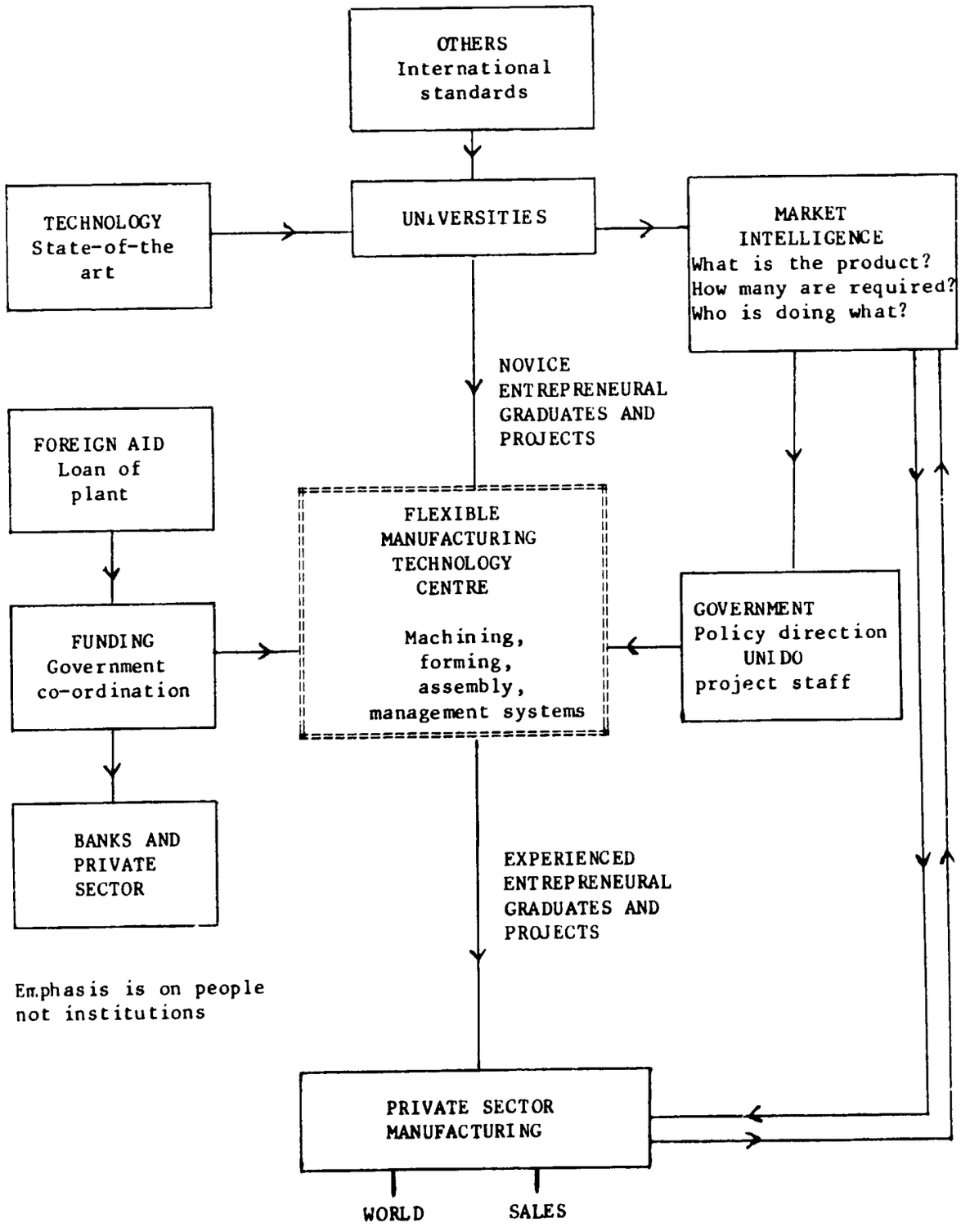
Figure 1. Technology transfer - bridging the role of the universities with the private sector



If we now look at the manufacturing scene in the OECD countries we find that there is a strong move away from the classical large company with big investment of plant dedicated to making a narrow range of products, to smaller 'cells' each capable of producing small batches of different products at economical cost. Appendix I lists the advantages and disadvantages of computer controlled machines and manual machines. Thus the factory of computer controlled machines linked by robots is only relevant to those countries with exorbitant labour costs and/or markets of stereotyped products such as car manufacture. There are already signs in Japan, one of the foremost countries to widely apply this approach to production, that the trend is being reversed.

The message which comes through loud and clear, therefore, is that large volumes of things are not being made by anyone for very long nowadays, in export markets, before the product is obsolete. Back to Alice in Wonderland.

The approach to this problem in the Western industrial world is to start a strong drive towards high technology production units in which the emphasis is given to:

1. Up-to-date market intelligence. Quick response to market demand. Short lead times and quick delivery.

2. Tight inventory control to minimize the high cost of storing material and partly finished goods.

3. Flexibility of production plant to enable diversification of products.

4. Concentration on technical design to minimize the material content as a foremost means of reducing cost.

6. What strategy should Thailand follow?

Can this approach be relevant to Thailand? How can this help to increase market share and develop exports? Suppose we now analyse the situation from fundamentals - the market. A customer nowadays is less concerned than he was, say, twenty years ago, about the country of origin of a product. World markets have become very much a free for all in which price, availability and quality are the main criteria, together with appearance and style - subjective

factors which seem to change with the seasons like women's hats and are very difficult to quantify.

Thus there is a strong argument in favour of adopting a fundamental policy in Thailand industrial restructuring which states that

> "If we can respond quickly to what the market demands, it does not really matter what the competition is doing and we can choose any market we wish and dominate it."

In this context speed of response extends from all levels of all government departments, through to manufacturing the goods and shipping them from the private sector.

7. Translation of market requirements to manufacturing

The effect of the above philosophy becomes very interesting indeed if we look at the present situation in the engineering sector in Thailand.

1. As there is relatively little major national investment in large, inflexible and outdated plant for the machinery sector, do we virtually have a green field and have nothing to lose by having a go at applying modern marketing, development and production methods demonstrated successfully in Europe and USA?

2. Can we apply the production engineering models of the West with modest investment, in a relatively short time scale?

3. Can we bridge the gap between universities and industry to ensure on-going product development and a plentiful supply of graduates with industrial experience most likely to be acceptable to certain sensitive manufacturing operations such as family businesses?

4. Can we exploit the proliferation of job shops in Thailand without turning the national cultural base upside down?

5. Do we need to rely on foreign technology for only few more years - the time it takes for a fresh crop of graduates to mature, before starting to innovate Thai advanced technology products?

The short answer for those questions is probably "YES".

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8. Practical considerations

(a) Time scales

There are other issues outside the scope of this paper which hopefully are being aggressively tackled elsewhere - strengthening the universities, formation of an Engineering Institute to create standards, tax incentives schemes etc., which among others are prerequisites to generating a technological base from which engineering products can compete internationally. In order to quantify the time scale required to materially achieve the objectives set out at the beginning of this paper it would seem that there is a natural 'law of the situation' in which the time required to set up the technological infrastructure to support the engineering sector is about two years. During this same period it would be feasible to introduce at least one high technology pilot manufacturing plant for evaluating the criteria for small batch, mixed product production essential for achieving the quick response which the market requires, and by example of how new products may be conceived and made, show how the industrial sector of the economy may then take off and compete in world markets. In addition, and in order to make best use of precious national financial resources it would now be logical to draw up a list of strategic products which would provide the catalysts, around which a future engineering sector infrastructure may be developed, e.g. engines, machine tools, microelectronics.

(b) Accountability

The success of the small business usually depends on one man directing the operation and making all the decisions. He can respond instantly to a crisis and/or make a committment which he knows he can keep.

The success of business intending to export will depend largely on a similar responsive management style. How will the export business be affected by the formation of recently proposed new institutions, particularly those involved with technology transfer? Will they speed up the response time to demand, or slow it down?

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Let us assume that the shortest response possible is obtained by one man, responsible only to himself, and having the necessary resources, including cash. He may be able to respond in, say, one week. How will his response be affected by the involvement of additional links in the chain between requirement and shipment of the goods? This, in addition of others, may add to the number of tasks, or burdens which he has to carry. Now there exists a simple mathematical relationship linking force (his effort) and inertia (other burdens) which affects time of response:

$$T \propto \sqrt{\frac{1}{\frac{E}{N}}}$$

E = Effort of 1 man
N = No. of extra men influencing progress
T = Time

(This is derived from a classical physical relationship

$$\text{frequency} = \frac{1}{2\pi}\sqrt{\frac{\text{STIFFNESS}}{\text{INERTIA}}}$$

Thus in the example illustrated, one man may execute a given task in one week. If now say, four more decision makers were interposed in the chain, his response time would increase and would probably extend to 2 weeks.

$$T = \sqrt{\frac{1}{\frac{1}{4}}} = 2$$

We may conclude that the creation of additional institutions to become involved in technology transfer may have a negative effect on export business, and alternative means should be sought to achieve the desired aims, such as strengthening existing channels of information flow.

9. Conculsions

To sum up then:

1. The government is seen to be the most powerful influence in future export policy, particularly in the field of export intelligence and

funding of products of long-term strategic importance, such as diesel engines, machine tools, microelectronics.

2. It is doubtful if it will be possible to make an impact on the economy by making changes in the engineering sector in the short-term, which can necessarily have long-term benefit. This is because of the primary need to establish a technological base comprising trained engineers operating within a formal system of internationally acceptable standards, which may take several years.

3. The role of the universities and technical schools requires strengthening so that they may be invited to accept a major part of the responsibility for spearheading the creation of the next wave of technological change, in keeping with examples in United Kingdom and USA.

4. A bridging operation is required between universities in their proposed new role and the existing manufacturing units in the private sector. This bridging operation is required to demonstrate by example how Thai engineering projects may be managed, from market requirement, design conception, prototype manufacture to full production.

5. The responsiveness of the manufacturing units is required to be encouraged to be versatile and economical in small batch production. Incentives may be required to encourage recruitment of graduate engineers who will be able to influence the introduction of new methods, materials and machines into traditional environments which may resist change. There will be the need for a 'National Technology Awareness' promotion scheme to get the message across.

6. The alternative to creating a strong Thai technological base is to either (a) leave things where they are; or (b) continue to pay high premiums to encourage foreign firms to start new products. The doubtful value of these alternatives requires little quantifying since experience to date shows a negative picture and an adverse balance of payments.

It is hoped that the points which have been raised in the context of an export strategy linked with the engineering sector, may provide a useful basis for further discussion and planning for success in world markets for the future.

Appendix I

Advantages and disadvantages of computer controlled and manual machines

Computer controlled

Advantages	Disadvantages
(a) Productivity of the workers is vastly increased.	(a) If incorrectly programmed, it will function improperly until corrected by human intervention.
(b) Permits the performance of tasks that are effectively beyond human capabilities, e.g. the optimization of complex processes.	(b) Requires large fixed capital investment which is frequently difficult to justify the normal accounting practice.
(c) Shorter runs of machines can be made at one time because the timing for set up and tooling are greatly reduced and basically irrelevant.	c) Does not create extra employment except in support services and diversification of product range
(d) The raw material inventory can be reduced if shorter runs can be made.	
(e) An NC machine or machining centre may replace two or more standard machine tools and thus eliminate some of the fixtures, guages, and tooling-or it may eliminate all of these in some cases.	
(f) All other elements being equal, the overall accuracy of NC-controlled operation can be expected tobe a considerable improvement over manual methods. Thus quality is high and scrap due to faculty parts is reduced.	

Manual

Advantages	Disadvantages
(a) Employs a large workforce, thereby helps reduce unemployment problem.	(a) Productivity of the plant may be lower than the automated system.

Advantages	Disadvantages
(b) Requires less investment than automated system; therefore may be more suitable for the very small job shop.	(b) Dependent on effective management and well-trained skilled labour.
(c) May possess more flexibility than the automated system for very small quantities.	(c) Cost of production may be higher than automated system for high volume production.
	(d) Quality is more difficult to obtain because of the dependance on human variables.

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Appendix 2

Notes on flexible manufacturing/machining

These notes briefly discuss the history and present state of development of flexible manufacturing/machining in the context of the need to promote advanced manufacturing methods in the engineering sector in Thailand. The role of the automated factory is also discussed to assist in making the distinction between flexible machining and automated manufacture.

'Flexible manufacturing' is a term used to describe a manufacturing cell which is capable of switching production from one product to another simply by describing the new product shape and quantity required, usually in the form of a computer input and includes automated assembly.

'Automated manufacture' is a term used for the replacement of manual operations used during machining and assembly, by means of robots.

'Flexible machining' is a term used to describe a computer controlled machine which is equipped with sufficient tools and work holding devices to enable a variety of parts to be made in any quantity, simply by selecting the appropriate computer programme.

Possibly the best known early example of flexible machining is the concept pioneered in England during the early 1960s by Theo Williamson who at that time was research director of Mollins Machine Tool Ltd. A number of systems based on the principle were constructed, known as Mollins system 24 and the systems are still in productive use. The system concept was patented and there are lawsuits being fought in all industrial countries at the present time, because of infringement of the patent.

The introduction of the low cost computer, or microprocessor as it is widely known, has now enabled even the simplest of machines to be microprocessor controlled at low cost, and offer many of the feateres of the Mollins system without infringement of the original patent.

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The Japanese have taken the concept and linked machines by robots to make an unmanned factory. The concept of the unmanned factory has aroused the imagination of many industrialists in the Western world because of rising labour costs and other industrial relations problems, and there are several examples in existence, notably making consumer electrical goods such as washing machines (a fully automated factory and not an example of flexible manufacturing).

The British Government is keen to encourage advanced manufacturing methods in UK and has paid half the cost towards consultancy studies. Results during the last 12 months, however, for studies aimed at promoting ll flexible manufacturing - some including robots and automated work handling - have shown that 90 per cent could not be justified economically. Of the remainder, the implementation phase will only apply a limited version of the FMS, confined to metal cutting, without automated handling.

There are also signs that Japan, the leader in application of the automated factory, is now relaxing the approach to full automation and one major Japanese machine tool company is now only offering flexible machining cells, not complete factories. Flexible machining cells are also available from UK, USA, Germany, Italy and Sweden.

How can these developments be of assistance to Thailand, bearing in mind the nature of the cottage industry manufacturing base? It would seen that by far the most relevant application would be to apply flexible machining, as distinct from flexible manufactuirng, methods to the wide range of major items comprising the present family of ICE and diesel engines. For example, a modern machining centre, equipped with automatic tool storage and selection for say, 80 tools, together with a system of paliet loading to enable parts to be prepared in advance in the right physical locations while the machine is cutting the previous component, could switch from say, engine blocks, to crankcases for an ICE in the morning, to engine blocks with a different number of cylinder bores for diesel engines, in the afternoon. This is because the shapes to be cut by the machine are described in computer language and the machine does not know what it is making in the conventional sense, i.e. when a

man is operating the machine. The operator is required however, to load and unload the machine.

In the case of a Thailand engine factory therefore, it would be most logical to concentrate on high cost items using such sophisticated machining methods described, and make all the small parts by existing small scale industry based factories. This would have the added advantage that several factories may be able to make the same parts and provide a reserve of capacity for fluctuations in volume demand.

The concept described is presently being applied in UK, Europe and USA and there are many case studies on file, particularly for engine manufacture, carried out by British machine tool suppliers, and several engine manufacturers are known to be implementing flexible machining systems, since they overcome the problem of making a wide range of parts in small batches economically.