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Case Analysis: How Foreign Technology Was Imported, Absorbed, and Diffused in the Machinery Sector of Korean Industry

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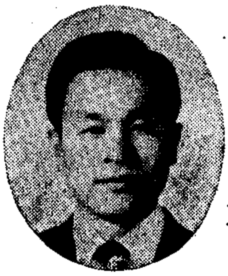

Preface

Since the process of case analysis does not have a classic or orthodox method, a major problem—or at least the first problem—in this type of study is to define clearly the objectives and scope of the work. For purposes of this report, we have adopted some definitions from several perspectives in order to continuously increase our knowledge and understanding about a particular economic sector (which is machinery in this report) and then tried to draw plausible hypotheses which could be generalized to other sectors of Korean economy and meaningful to policymakers on science and technology.

A case analysis thus has a beginning but no end. Instead, every step of the process is a gate that opens up several other areas requiring research and investigation.

This report is by no means a final dictum on the role of technology in the machinery sector; instead, it is intended to expose some important questions and hypotheses on productivity and the role of technology in this particular sector of Korean economy.

Information on the Firm Concerned

Name and location

Name of the firm: Hankook Machine Industrial Co., Ltd.(Hanki) Later the name of the firm was changed to Daewoo Heavy Industries Ltd.

Location: Head administrative office and factory, 6, Mansuk-Dong, Dong-ku, Inchon, Korea.

Historical Background

The firm concerned in this study was founded in 1937 during the Japanese occupation as the Chosun Machine Works. During that era it produced industrial machines, mining equipment, and occasionally, weapons such as artillery and small sized submarines.

After Japan's retreat in 1945, the firm was nationalized by the government and, as a government workshop, resumed production of industrial machines. However, in 1963, to meet the demands for machines following the commencement of the nation's economic development plans, the government established the company as a corporation under the name of Hankook Machine Industrial Co., Ltd. and then in 1968, transferred its shares and management to private hands.

Since then, the company has extended business areas and diversified its main products step by step. In 1973 the company merged with the Bugok Rolling Stocks Plant and added to its products railroad cars and coaches. In 1975, the company established the Diesel Engine

Plant and began to produce M.A.N. engines in technical collaboration with the Maschinenfabrik Augusburg-Nuernberg Aktiengesellschaft and financial assistance from the German Government.

In 1976 the company also merged with the Daewoo Machinery Company. Through successive mergers and investments, the compamy has enlarged to include four main plants:

the Industrial Machine Plant
the Diesel Engine Plant
the Rolling Stocks Plant
and the Precision Machine Plant.

In managerial developments, the year 1975 was an epoch for the company. Despite its leading role in Korean industry the company had been in chronic deficit until 1975, mainly due to the lack of domestic demand and to unstable management. However, in 1976, the Daewoo Industrial Company, Ltd. together with its affiliates, took over 46.2% of the total shares of the company and participated in management. The Daewoo Industrial Company is one of the largest trading companies in the world with annual international sales of about U.S. $ 1 billion currently, and is rated as the most promising one for its excellent managerial ability.

In managerial and financial collaboration with the Daewoo members and their worldwide branches for sales promotion and financial facilities, the company, renamed as Daewoo Heavy Industries Ltd. in October, 1976, planned a large investment in the Industrial Machine Plant and launched an ambitious project in heavy industries, including engineering services and plant sales on a turn-key basis.

Technical Collaborations

So far the Daewoo Heavy Industries Ltd. has had agreements covering technical collaboration with the following foreign firms:

— Isuzu Motors, Japan : for small type diesel engines of trucks and buses
— Kuboda Co, Japan:for marine diesel engines
— Komatsu Works Ltd, Japan : for fork lift trucks
— Nippon Drop Forge Co. Japan : for die forged products
— Nippon Sharyo Seizo Co. Japan : for rolling stocks
— Tokyo Juki Ind. Co., Japan : for high-speed industrial sewing machines
— Ikegai Iron Works, Japan : for high-speed precision lathe
— SCTCO, U.S.A. : for barber type bogie
— Hitachi Construction Machinery Co,Japan : for excavator mobile crane
— Kurita Water Ind, Japan : for water treat ment facilities
— Hamai Co., Ltd : for production milling
— TEL-SAN Die Cast Co., Ltd. : for die cast ing products
— M.A.N., West Germany : for M.A.N. type diesel engines.

Focus on Diesel Engine Production:

Since mid 1969 the company had made investigations into the German diesel engine manufacturing industry with the aim of manufacturing water-cooled diesel engines in the power range from 50 to 200 Hp under license. The investigations carried out in this matter until July 1970 and the negotiations entered into showed that engine types produced by M.A.N. and Daimler Benz AG coincide most of all with the conceptions of the company.

On the 31 August 1970, as the result of further negotiations, a license agreement was concluded between the companies

Maschinenfabrik Augusburg-Nuernberg AG (M.A.N.)
Augusburg, Federal Republic of Germany as the licensor

and

Hankook Machine Industrial Co., Ltd.
(Hanki) Inchon, Korea

as the licensee.

The subject matter of the agreement concerns the diesel engines built by M.A.N.

— type D 0844 M, power 50 to 90 HP, DIN
— type D 0846 HM, power 130 to 160 Hp,DIN plus all modifications and improvements to the engines (effected by M.A.N.) effected during the period covered by the agreement.

The agreement was concluded between M.A.N. and Hanki as a result of the speedier negotiations and the more favorable financial conditions which became apparent during the preliminary negotiations.

Scope of the License:

The license authorizes Hanki

— to manufacture the said engines
— to draw relevant engine parts from third parties
— to market the engines in Asia, with the exception of India and Turkey
— to manufacture and market single parts as spare parts for the said engines.

The services of the licensor cover accurately specified information and documentation relating to the objects of the agreement. In addition, a skeleton agreement was drawn up relating to the residence of specialists employed by the licensee in the country of he licensor and vice-versa. The licensor also assures the licensee the use of his own industrial rights and declares his willingness to make available foreign rights used by himself to the licensee under the most favourable conditions which can be obtained.

Royalties:

The fees agreed upon in the contract are subdivided into

— a single basic fee of DM 500,000.
— a current piece royalty, calculated by multiplying the following fee rates and the home production share of Hanki.

The basic fee of DM 500.000.— is to be payed in three installments:

— first installment within 2 months of authorization by the Korean government, at the latest 3 months after the granting of a credit by the Kreditanstalt für Wiederaufbau, Frankfurt/Main for the acquisition of equipment to manufacture the objects of the agreement DM 200,000.—
— second installment within two years of signing the license agreement DM 200,000.—
— third installment within three years of signing the license agreement, DM 100,000.—

The fees for the current, piece royalties are as follows:

— for the first 15,000 liter, cylinder capacity, in one year of contract, DM 22.50 per liter
— for the next 15,000 liter, cylinder capacity, in the same year of contract, DM 18.75 per liter
— the third 15,000 liter, cylinder capacity, in the same year of contract, DM15.—per liter
— for the fourth 15,000 liter, cylinder capacity, in the same year of contract, DM 11.25 per liter
— for all further engines in the same year of contract, DM 7.50 per liter.

These fees are increased if the engines are exported from the manufacturing area which covers Asia with the exception of India and Turkey.

A license fee of 5% of the respective M.A.N. CKD list price has been agreed upon for the spare parts manufactured by Hanki.

In the event that M.A.N. supplies Hanki with more than 50%(in terms of value) of the parts for the engines to be manufactured under license and providng that at least 1,500 pieces are supplied per annum, Hanki need then pay only 50% of the minimum royalties.

Duration of the License Agreement:

The agreement is due to run for five years after the commencement of production. It may be renewed for a further five years. In this eventuality the royalties for the period of renewal are to be negotiated anew. After ten years of production no royalties are levied.

Contract concerning the employment at M.A.N. of Korean skilled workers

On 28 October, 1970 a skeleton contract was concluded between Hanki and M.A.N.providing for the employment of a total of 500 Korean skilled workers by M.A.N. at the engine and truck manufacturing plant.

According to the terms of this contract the first Koreans, numbering 20 at the beginning, should be starting work at M.AN. on January 1, 1971. This number should be increased by approximately 70 men during the early part of the year. Further increases in the number of Korean workers depends on the amount of experience gained in the first six months.

Functions plan

The functions plan shows in schematic form the ideal production cycle, taking into account the optimum coordination of preproduction, production and storage ranges plus the associated subsidiary functions. The functions plan (technologically conditioned material flow)was worked out during the first planning section, and, on the occasion of the talks in Inchon, accepted by the company.

The functions plan is shown in fig. 1. A rough division of the production ranges is shown along the top edge of the functions plan. This division shows the main ranges, these being receiving store, installations for preliminary operations, intermediate store, (machines) production, assembly lines, finishing shop, completed products.

The material flow is indicated by arrows.

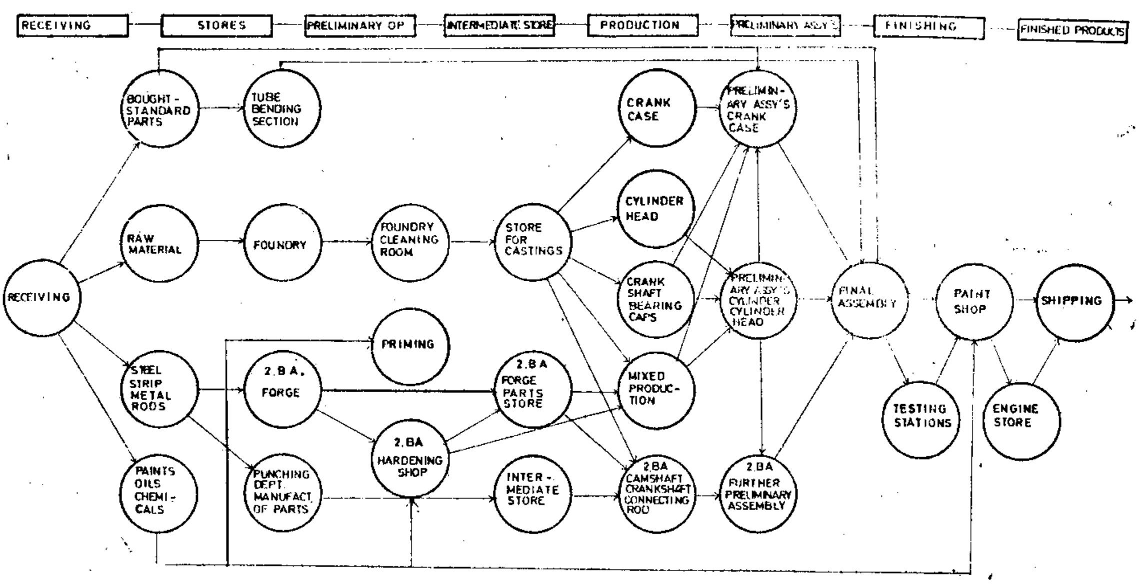

Fig. 1. Functions Plan, Engine Factory

The factory ranges through which materials pass are named in correct sequence from left to right in the headings along the first line of the functions plan.

Material flow:

The schematic illustration of the material flow supplies information on the volume of material transported between the individual processing or manufacturing zones.

From the store for bought parts and standard parts the material travels directly to the corresponding preliminary or final assembly point. The raw materials required for casting are taken from the raw materials store to the foundry, via the foundry cleaning room to the casting store.

At this point the material flow diverges: the individual ranges of the mechanical plant are supplied with the complete castings. These ranges are:

— crank case manufacture
— cylinder head manufacture
— crank shaft bearing cap manufacture
— a prescribed part of the 'mixed' production unit.

Subsequently these branches of the material flow lead to the preliminary or final assembly. Starting at the sheet steel, strip material and rod material store, those materials which must be forged pass through the forge and hardening shop, are primed and finished up in the 'forged, parts store. They are processed further during the mechanical production procedure; here special reference must be made to these parts, flywheel, crank shaft, cam shaft, rocker arm and connecting rods. Further small parts are dealt with in the'mixed' manufacturing section.

After the mechanical processing of these parts has been completed they pass the prelimi nary assembly to the final assemby. In the following line of the material flow chart the use of paint, oils and chemicals in the production procedure is indicated. These materials are used in various production ranges.

Forge:

The forge was built in the second expansion stage(1976). The most important forge-produced parts of a water-cooled diesel engine are;

— crank shaft
— counter weights
— rocker gear
— rocker gear bracket
— gears
— gear rings
— connecting rod
— cam shaft
— valves

In order to produce forge blanks for the parts listed the following operations are necessary:

In the hammer mill; cutting, hand forging, pressing, upsetting.

The following machines are used:

cold circular saw, high speed swaging hammers, upsetting machines.

Operations in the drop forge:

initial heating of the rough forgings,
initial upsetting of the rough forgings
drop forging.

For these operations the following machines are normally required:

Preheating equipment(gas -heated or induction heated),
friction screw presses,
die-stamping presses,

Operations in the straightening section:

upsetting
pressing
calibrating
grinding and polishing
surface treatment
aligning

For these operations the following machines are used:

friction screw press
eccentric press
sizing press
grinding and polishing machines
cleaning drums and sad blasting equipment

aligning machines or workbenches with devices for aligning by hand

Operations in the reannealing plant:

reannealing

treating of surfaces

The following equipment is used:

isothermal annealing plant

blasting equipment

bonding epuipment

Most of the forge-produced parts used in the diesel engine are drop-forged. For this reason the first planning considerations only envisaged the construction of a drop forge with annealing plant.

After working the material in the forge the rough forgings are taken directly to the store for unworked parts situated before the mechnical production sector.

Mechanical production:

In the mechanical production section the workpieces are manufactured on highly-automated individual machines such as rotating tables or other cyclic machines which are linked together. The following workpieces are dealt with in the mechanical production section:

— crank case
— cylinder head
— crank shaft bearing caps
— crank shaft
— cam shaft
— connecting rod
— rocker gear bracket
— rocker gear
— flywheel

Crank shaft line: Equipments were provided in the crank shaft line for the following operations:

— cutting to length
— centering
— turning
— circular threads
— drilling
— induction hardening
— balancing
— washing

Cam shaft production: Equipments are provided in the cam shaft line to carry out the following operations:

— centering and aligning
— turning
— drilling
— cam shaping
— induction hardening and unstressing
— grinding with circular grinding machine
— grinding with cam grinding machine
— checking and testing
— washing

Manufacture of counter weights for the crank shaft: Equipments were provided to carry out the following operations;

— miling
— driling
— trimming
— weighing

Manufacture of connecting rods:

The following equipments were provided for the manufacture of the connecting rods;

— rotating table machines for milling and grinding the lateral surfaces and for machining two other supporting points of the connecting rod.

Manufacture of flywheel and gear ring:

In the case of the manufacture of the flywheel and the gear ring equipment is required for the following operations;

— turning
— tracer turning
— drilling
— milling or shaping of the teeth of the gear ring

Further Development:

The initiation of production took place in

May 1975, even though the production depth then was rather shallow. However, in the second stage of expansion about DM 30 millions were spent for crank shaft, cam shaft, and connecting rod production lines the completion of which took place in March 1976.

Even though the nomial production volume of the engine plant was designed at 24,000 pieces per year, actual figures for production since its operation in 1975 are as follows:

	1975	1976	1977	1978
Production:	1,120	2,578	9,385	15,206
sales:	285	3,119	9,313	15,041

Production and sales Figures(unit;pieces)

In 1975 there were three major automobile manufacturers in Korea. However, they were very much reluctant to use the diesel engines Hanki produced. There were several reasons for their reluctance. First, they had no confidence in the quality of domestic engines. They were already having problems with the quality of many other automobile parts which were supplied them domestically.

Second, there was either insufficient or even negative price incentives to use domestic engines. This phenomenon, which was easily observable not only in automobile engines but also in most of other machineries or their parts productions areas, ensued from following reasons.

— Because of restricted market size, what is called the economy of scale in production was far from being achieved.

— Most of know-how parts and raw materials were imported from abroad at expensiver cost. This was because the order quantity was not large enough(also due to smaller market size) to be negotiable for cheaper price, while most buyers were in positions of captivity nature.

— Most of machineries and facilities were bought on foreign or domestic loans, and hence, prices of their products bore the burden of interest portion.

— Costs incurred from inexperiences and lack of management know how were transferred to the price of their products.

Third, there were technical problems to overcome for the engines to be mounted on automobiles. Engines are not final products by all means. An engine is a subsytem of a bigger system. Hence, there always exists a certain degree of interrelationship between the subsystem and its total system. Therefore, for an engine to be mounted on a vehicle some technical problems to integrate the two into a functioning system should be solved unless the two were designed initially as a system.

In 1975 Hanki had no capabilities to overcome those above stated problems and the company ran into insurmountable financial troubles. However, in 1976, the Daewoo Industrial Company, Ltd. took over the company and participated in management. Daewoo asked the Korean Government to ban the importation of diesel engines from abroad and the Government accepted Daewoo's proposal as plausible, while the price of diesel engines came under the control of the Government.

On the other hand, Daewoo launched a project to work out the mounting problem. First, Daewoo's project team worked in close contact with the KIST(Korea Institute of Science and Technology). Next, as for critical areas which calls for deeper technical know-how Daewoo asked M.A.N. for further information. After a year's hard work and endeavor Daewoo resolved most of the problem areas to mount their diesel engines on buses, trucks, and other heavy-duty vehicles which were being manufactured in Korea.

Since the techical problems to mount Dae woo engines on buses and trucks which were manufactured in Korea were resolved to satisfaction, and owing to the government's protection policy on diesel engines, the demand for Daewoo engines has increased steadily.

On the other hand, Korea economy as a whole has grown at more than 10% annually while export activities have grown at about 30 % per annum. This phenomenal growth or national economy as a whole has called for more and more transportation requirements during the latter part of 1970s. To meet this demand increase in transportation activities more buses, truoks, construction vehicles should be built, while requiring more diesel engines.

As their demand increases, diesel engine production has been set in orbit and as a result various manufacturing techniques and knowhow have been learned and absorbed.

However, their technology level has not yet reached the stage in which they are able to modify or improve their model such as power-up, power-down, reduction in weght or noisel evel, etc. As of May 1979 designing and producing a new model of their own is far beyond the horizon of sight.

Another Case for Comparison with Diesel Engine Case.

Name and location

Name of the firm: Yuhan-Kimbely Corporation

Location: 302-75 Dongbu-Ichon-Dong Yongsan-Ku, Seoul, Korea

Our preceding diesel engine manufacturing case was the one in which highly involved technologies were prevalent. Now another case with rather simpler technologies will be studied here for the sake of comparison between 'complex' and 'simpler' technologies. This second case study was done on the Yuhan-Kimberly Co., Ltd., a cosmetic or sanitary tissue manufacturing firm in technical collaboration with the Kimberly-Clark Corporation of the U.S.A.

Development:

Since 1968 the Kimberly-Clark Corporation of the United States of America had been groping for investment opportunities in Korea. They were interested in setting up a foothold in Korea.

Yuhan Corporation of Korea, a pharmaceutical company of high repute for their public interest orientation with solid marketing channels, was recommended via the U.S. Embassy in Korea to the Kimberly Clark.

At that time the Yuhan, as a pharmaceutical firm, was interested in considering the production of sanitary(feminine) napkins.

As negotiations between the two parties proceeded, Yuhan learned that they had to import what they called 'warding', the semifinished absorbent tissue material which should be put in for the final output of feminine sanitary pads. However, the transport problem of the warding material, being so huge in volume, was posed as a serious difficulty to overcome.

Eventually Yuhan concluded and began to insist that they would like to set up warding production facilities in Korea. However, Kimberly- Clark mantained that the market size is too small in Korea to justify the capital expenditure to invest in warding production plant.

While the negotiaion was lingering at a stalemate in this way, Kimberly-Clark team began to learn about 'the Korean style of getting things done' …for example, they noticed that most of street buses in Seoul were built via unorthodox manufacturing processes by many small diverse companies with low capital and ill-equiped facilities.

They learned that the ingenuity, sincerity, and diligence of Korean people could somehow get things done which to the eyes of western people might appear infeasible.

This growing confidence in people lead the Kimberly Clark team to understand Yuhan's assertion and finally they agreed to establish a joint-venture company (Kimberly-Clark 60%, Yuhan 40%) with warding manufacturing plant for which Kimberly-Clark was supposed to supply needed technical know-how.

At that time, in early 1970, the status of tissue manufacturing industries in Korea was still in a primitive stage. Bath room tissue rolls were produced using machineries and facilities designed manufactured and in Korea based on time-old traditional method. Yuhan managed to secure several engineers who were able to design and construct the old style paper manufacturing machineries. Those engineers were sent to the Kimberly Clark in the U.S.A. on a mission of learning about the 'modern' technology for cosmetic tissue manufacturing. They made tours on several paper mills and collected information about designing, assembly, and critical parts for the construction of tissue manufacturing machinery. Above all they learned that the basic principles of 'modern' techniques are not too far from those of traditional ones as far as paper tissue manufacturing is concerned.

After returning home they started to construct the machinery to produce absorbent paper tissue on the basis of blue prints, information, and other technical assistance supplied by the Kimberly-Clark. They tried to design the system as simple as possible. Some parts were produced in their own machine shop, while many others were made through subcontracts by local machine shops. Some of very critical parts were sent to the U.S.A. for tests. Those parts which were beyond the capability of domestic prodution were imported.

In December 1970 the machinery system for the production of absorbent paper tissue was set up and operation started. The system was much simpler than those in advanced countries. As for quality,the production speed was slower than the 'advanced' sophisticated machines. However, the quality of the product was about the same.

Considering the small size of capital expenditure in constructing the machinery, the result came as a surprise to the Kimberly-Clark side.

Yuhan-Kimberly's next project was to set up felt producing machinery. So far most of felt products were imported from abroad. Hence, domestic production of felt was in a serious need. Kimberly-Clark agreed to supply needed technical assistance including drawings, blue prints, and informations about parts and assembly of the system.

Owing to experiences and learnings attained during the first mission, the felt producing machinery system was set up without much difficulty in February 1972.

On the other hand, due to fast growing national income and rising standard of living in Korea, the demand market for cosmetic tissue, sanitary feminine pads, and felt products was ever growing at about 50 to 60 per cent annually.

To Keep up with market growth, Yuhan-Kimberly decided to expand their production facilities. About three fold expansion project was approved by the government in January 1972 and the project was completed by July 1974. The company's growth data are shown below:

	1971	1974	1977
Export*($ 1,000)	235	650	2,300
Assets(million won)	397	1,880	3,196
Employees	206	417	430

* Domestic sales data were classified.

Growth of Yuhan-Kimberly

Starting 1975 as a turning point, Kimberly-

Clark Co., now having complete confidence in Yuhan-Kimberly's machine manufacturing capability, contemplated strategically fostering Yuhan-Kimberly as a machinery supply base for their international market of paper manufacturing machineries. Korean people's capability in designing, drawing, manual skill in machining, in addition to their sincere attitude toward learning, and above all cheap labor cost were presumably major factors which lead them to this decision.

The first development in this direction took place in the form of machinery parts export to Iran in 1975. In the same year engineers and operators of tissue manufacturing machinery were sent to the same country as a technical assistance program to the nation. In 1976 Yuhan-Kimberly exported machineries(of cosmetic tissue and felt manufacturing) with some major parts to Philippine and Thailand.

In 1977 Yuhan-Kimberly exported a whole system of paper manufacturing plant to Columbia and sent five engineers for their operation.

Recently Yuhan-Kimberly functions, as it were, like an R&D laboratory for Kimberly-Clark. With technical assistance and guide from the American counterpart, they succeeded in producing crescent former — a higher stage technology in paper industry.

Significant Findings from Case Studies

1. Continuity of demand for the products is considered to be of crucial importance for the accumulation of technical knowledge appertaining to the products and/or production process thereof. Without the continuity of demand for the products the continuity of men engaged in the activities of production or further development of the products is not possible in general. When the continuity of men engaged in technical activities lacks, the accumulation of technical knowledge in the related area is seriously hampered.

This phenomenon was markedly experienced by Daewoo Heavy Industries Ltd. in regard to diesel engines. At the earlier stage of the diesel engine production there was not enough demand in the market for the engines. Hence, personnel who were employed in the diesel engine project were transferred to other projects. The company could not afford to keep the personnel in the project where they were losing money due to lack of market demand for the product. In most developing countries even the largest companies are uaually not sound enough financially to support highly-paid technical in a project which is in the red.

POLICY IMPLICATIONS: Generally in developing countries the following circumstances are observed;

a. Measurement of correct market potential for some product is harder in developing countries than in developed ones.

b. In developing economies competion among entrepreneurs who wish to launch a new project is likely to be excessive especially where there is not yet well-established leader in the new field.

Under these circumstances the developing country's government, which is easily swayed by big business corporations, is apt to give approvals to duplicate investment proposals which result usually in overcapacity problems relative to potential market demand. When this happens, it causes in the course of time the discontinuity of enough market demand for satisfactory accumulation of technological knowledge and experience to take place in the developing economy.

In this given context it might be argued that developing country's government should be very careful in giving approvals to duplicate investment proposals which may result in excessive competition among contending enterprises.

It should be hypothesized here that excessive competition transcending a certain level could be detrimental to the sound accumulation of technological capabilities in a given field.

2. Employment contract between the recipient and the supplier of technology plays an important role in the transfer of the technology. An agreement was drawn up in 1970 between Han Kook Machine Industrial Co. Ltd. and M.A.N. of German Federal Republic. According to this agreement about 350 technical manpowers from Hanki were sent to Germany in 1972 to be employed there at M.A.N. as manufacturing laborers.

At the expiration of the employment contract they returned home to resume their jobs at Hanki. With their experiences and practical training they came by in Germany, they play a decisive role for the production of diesel engines on a large scale. This kind of employment contract is different in nature from a training program in that;

a. the size of people involved was on a larger scale than usual for a training program,

b. the period during which they stayed with the supplier firm of technology was much longer than that of a training program, here in Hanki Case more than two years,

c. and while they were with the technology-supplying firm, they got paid and treated as employees for the contracted term, etc.

This kind of employment contract program will be only possible when the technoligy-supplier can afford to and is willing to accept such a large number of people as their employees for a certain period of time, usually for a couple of years at least. In the Case of Hanki and M.A.N. this was possible since towards 1972 there was a shortage of skilled manpowers in Germany.

To sum up, employment contract which enables technical manpowers from the developing country to have opportunities to work at the technology-supplier firm as employees for a certain period of time has deen proved in Hanki-M.A.N. Case as an efficient means to transfer or learn technologies from developed countries.

3. Satifactory human relationships between the supplier and the recipient of technology seems to be more important for smooth transfer of technology than formal contents of contract or agreement. Investigation of Yuhan-Kimberly Case strongly revealed this hypothesis. In the beginning Kimberly-Clark Corporation was hesitating about transferring plant technology for manufacturing tissues to Yuhan. However, after having been assured of diligence, sincerity and intellectual capabilities of Korean people, Kimberly Clark began to disclose more than were written on the agreement. This confidence of Kimberly-Clark in Yuhan, which was developed in the course of time through satisfactory and smooth human relationships between the two parties, became a prime mover which provided motive power to Yuhan's success reaching up to exportation of plant in tissue manufacturing to developing countries.

Thus if the broad truth of this hypothesis is confirmed and generalized elsewhere, the need for special attention in favor of human factor study in technolgy transfer process should be suggested.

4. Our case studies have confirmed the importance of distinguishing between the core process and peripheral processes. In the light of study results so far completed, the greater ease of adaptation in the peripheral activities may be partly a matter of limited capacity to adapt. For both cases of Daewoo-M.A.N. and Yuhan-Kimberly, peripheral activities offer easier and more obvious opportunities for labour-intensive adaptation.

Interestingly, incentives for adaptation were created through Cost-down movement as a subset of Saemaeul Movement. Saemaeul Movement is a government-sponsored nation wide movement encouraging the whole Korean nation to be more productive and constructive through maintaining new attitudes and spirits. In industrial manufacturing factories and plants this Saemaeul Movement has been crystalized as cost down and quality-upgrading movement.

Some of efforts from technical manpowers to achieve these goals of Saemaeul Movement has been connected to success in adaptation of some part of production technology in peripheral areas where their capacity to adapt was in proximity to some success.

To take an example from Daewoo's production of diesel engines with M.A.N licensing, some portion of machining processes for crank shafts has been successfully adapted for Korean situation from original M.A.N. design.

Investigations on the differences between Korean vehicles and those of Western countries in mechanical structures in the vehicles indicated that transmission center shafts are shorter with Korean vehicles than Western ones. This finding lead to the fact that there was no need for machining process on pilot Bearing Hole at the rear of Crank Shaft. (Original M.A.N. design indicated need of machining on this hole.) This machining process adaptation has resulted in estimated production cost savings amounting up to U.S. $ 30,000 per year.

Our case studies have identified several of this kind adaptation successes in peripheral areas of manufacturing processes.

5. "Suitability Gap" in employed technology differs from a subsector to another even in the same sector of industry in Korea. By suitability gap is meant the gap between the actual degree of complexity of imported technology and the reality's need for that degree. In this subproject case analysis on machinery sector of Korean industry, Daewoo-M.A.N. Case is the one where a high degree complexity or specialised automation was involved whereas Yuhan-Kimberly case is quite the opposite.

The concept of suitability gap is meaningful in relation to the capacity of adaptation from the imported technology for the local needs. When a developing nation is in greater need of learning, adaptation, and diffusion of imported foreign technology, she might be better off by starting with simpler technologies. Simpler technologies are to be absorbed and understood with much ease than sophisticated ones. A better understanding and absorption is indispensible for adaptation of foreign technology for local situations.

Our case studies have also indicative of the fact that adaptation process can be connected eventually to the indigenisation of foreign technologies. By this is meant the duplication and local reproduction of imported technologies subject to the constraint of patents. Apparently, Yuhan-Kimberly case can be quoted as evidence that cost advantages were achieved where cosmetic tissue manufacturing machineries were indigenised, eventually resulting in dramatic success of exporting machineries and plants to underdeveloped countries.

Executives and top managers from Yuhan-Kimberly Corporation emphasised that their success in technological development was primarily attributed to the fact that they adhered to simpler technologies.

However, diesel engine manufacturing technologies are quite different from those of cosmetic tissue manufacturing. Precision, standardisation, and consistency are major factors which should be given primary considerations in engine manufacturing. Hence, due to these reasons, engine manufacturing techniques are rather sophisticated with higher degree of automation mechanisms. Thus, as far as the need for adaptation and indigenisation is concerned, the suitability gap was wide with core technology areas of Daewoo-M.A.N. Case.

6. As pointed out in section 5, in case of products like engines precision, standardisation, and consistancy in manufacturing process are primary determinants for the final quality of products. When developing countries hope their products to be competitive in international markets, the requirements of quality of their products call for importation of foreign techniques which are designed to be sophisticated with specialised automation control mechanism.

Dilemma Hypothesis:

At this stage in the case analysis, the following hypothesis could be drawn out of Daewoo-M.A.N. Case in relation to core technologies of diesel engine manufacturing;

The importation of sophisticated technologies in order to be competitive in international markets inevitably functions to hamper the required adaptation, indigenisation, and diffusion of the imported technologies.

To the extent that this reasoning applies, the situation places developing nations in something of a dilemma; when a direction in being competitive in international markets with the final products is to be followed, the other direction in raising technological capabilities by understanding, absorbing, adapting, and diffusing the imported technologies should be sacrificed in the long run, and viceversa.

Policy Suggestion:

The importation of foreign technology is advised to be done in such a way that a limping balance between internationally competitive, specialised, and highly automated technologies and simple, easy-to-learn technologies may be maintained so that with the former one can produce products which are internationally competitive and on the other hand one can learn,duplicate, adapt, and diffuse the imported technologies. The limping ratio in the balance may be chosen according as the situation concerned needs. In case of Daewoo-M.A.N., our case analysis has figured out the limping ratio to be about 90:10 with respect to machine tools.