

**Absorption, Assimilation, and
Diffusion of Imported Technology
— A Case of a Machinery Company in Korea in the 1970s —**

**Suck-Chul Yoon
Seoul National University**

I. Introduction

This article tells the story of a Korean machinery firm, which sought to absorb imported foreign technology, assimilate it and then diffuse it in the 1970's to Korea. Through this story, the reader will gain an understanding of the political, social, and economic context in which Korean enterprises managed their businesses in a decade of rapid economic growth. This case will also illustrate the role that the Korean government played in assisting businesses in building up their competitive strength in order to make a positive and significant contribution to the growth of the national economy.

The firm which will be examined was founded as the Chosun Machine Works in 1937 when Korea was still under Japanese occupation. During that era it produced industrial machines, mining equipment, and weapons such as artillery and small submarines. After Japan's retreat in 1945, the firm was nationalized by the Korean government and resumed production of industrial machines under government management and control.

In 1968, the Korean government handed the company over to private hands. The new owners changed the name of the company to Hankook Machine Industrial Co., Ltd. (to be abbreviated as Hanki). Since 1968, the company has extended into several new business areas and diversified its main products aggressively. Despite its leading role in the machinery industry in Korea, however, the company experienced chronic deficits until 1975, primarily due to the result of insufficient domestic demand for their products. In 1976, Daewoo Corporation, one of Korea's top five business

groups, took over the company and renamed it Daewoo Heavy Industrial Company(DHI) Limited.

II. Business Environments in Korea in the 1970's

Despite the rapid economic growth achieved during the First and Second Five-Year Economic Development Plans(1962-1971), the Korean economy was still struggling with the problems it had inherited from the chronic poverty of the past. Insufficient domestic savings, heavy dependency on foreign capital for development financing, chronic inflation, a backward industrial structure, and a lack of industrial technologies were all problems that had yet to be resolved at that point.

With the level of capital accumulation negligible, and the volume of trade very small, the ability of most Korean business firms to raise much-needed capital through self-financing was limited. Most business enterprises could not finance even with the help of foreign loans. The capital which could be raised through the issuance of public stocks or debentures was simply inadequate. Under these circumstances, the Korean government established some guidelines to facilitate the financing needed for economic development while fostering the stock market and campaigning for the promotion of domestic savings. Foreign direct investment was also encouraged, but restricted up to a level of 60 percent of total equity. Foreign loans were approved and guaranteed by the government only when they were to be used for the acquisition of capital goods and advanced technology which were not available locally.

III. Governmental Policy Measures

In order to accelerate the growth of the national economy, aggressive strong policy measures were adopted by the Korean government. The three most important measures were :

- (1) the promotion of the Saemaeul(New Community) Movement to rear rural development by stimulating the spirit of diligence, self-help, and

cooperation among farmers and fishermen ;

- (2) the Presidential Decree of August 3, 1972 to alleviate the financial burdens of business enterprises by coercing all curb-market financing terms into bank rate loans, and
- (3) the Presidential Declaration of a Heavy and Chemical Industrialization Policy of January 12, 1973.

Of these three policies, the third measure had the most significant impact on the technological advancement of the Korean machine industry. Heavy imports of capital goods, as well as industrial raw materials, caused serious balance of payment problems and made the economy more dependent on foreign savings. Thus, the Korean government wanted to enhance industrial independence through increased domestic production of both industrial raw materials and capital goods. Therefore, the steel, petrochemical, and non-ferrous metal industries were selected for intensive development as suppliers of raw materials. On the other hand, the government focused upon the machinery and electronics industries for development of capital goods suppliers.

Because demands for equipment funds were expected to grow much more rapidly than in the past, the National Investment Fund was established to finance the construction of heavy and chemical industries. The purpose and character of the National Investment Fund may be summarized as follows: First, the Fund was created to provide additional capital, in addition to equity and foreign loans, required for the construction of plants planned for both the heavy and chemical industries. Working capital requirements were given secondary priority, but these needs could also be financed with loans from the Fund. Second, the plan was to supply low interest loans by means of establishing a combined pool of funds from citizens' bank deposits, which were induced at high interest rates, and funds subscribed by the government at zero rate of interest. In this way the government sought to provide long term loans for the construction of heavy and chemical industry plants at extremely low interest rates. Third, the maturity period of the loans issued by the Fund was far longer than the traditional five years, with flexibility depending on circumstances.

Industrial sites were also constructed through government initiatives. In order to support the construction of selected industrial sites, the Industrial

Site Development Promotion Law was enacted in 1973. The Korea Water Resource Development Corporation, which was established in 1967, was also reorganized in order to enhance its ability to work effectively with other programs involving industrial site construction and development. The Gumi Electronics Industry Complex, Changwon Machine Industry Base, Yecheon Chemical Industry Base, and many others were constructed by the Industrial Sites Development Corporation. Another important supporting measure provided by the government to promote the heavy and chemical industries was the construction of infrastructure such as harbor facilities, communication networks, highways, and industrial roads to support commerce.

IV. Importation of Diesel Engine Technology by Hanki

Encouraged by government guidance and the supporting measures described above, Hanki began to investigate the possibility of manufacturing diesel engines. Hanki management believed that as Korean industry began to expand, the transport volume of industrial goods would also increase, and thereby create a demand for diesel engines for trucks and buses. Their investigation showed that the engine types produced by M.A.N. of West Germany were the most suitable for their purpose.

Negotiations between Hanki and M.A.N. proceeded faster than was usual due to favorable loan conditions from the German fund, Kreditanstalt für Wiederaufbau of West Germany. On August 31, 1970, a licensing agreement was concluded between the two companies :

Maschinenfabrik Augusb-
Nürnberg(M.A.N.) Augsburg,
Federal Republic of Germany as the
licensor :
and
Hankook Machine Industrial Co.,
Ltd.(Hanki) Inchon, Korea as
the licensee.

The central objective of the agreement was to produce diesel engines of type D 0844, power 50 to 90 HP, DIN and type D 0846, power 130 to 160 HP,

DIN, including all modifications and improvements made to the engines during the period covered by the agreement. The scope of the license contained marketing of the engines in Asia, except India and Turkey. The services of the licensor were to provide the specific information and documentation needed for the production of engines. The licensor assured the licensee the use of its own industrial rights plus foreign rights which the licensor was allowed to use. The agreement was due to run for five years after the commencement of production, when it could be renewed for a further five years. In this event, the royalties for the period of renewal were to be renegotiated. After ten years of production no royalties were to be levied. The royalty fees agreed upon in the contract were subdivided into a single basic fee of DM 500,000, and a current fee. The current fee rate was to depend on the accumulated volume of production. For example, for the first 15,000 liters of cylinder capacity of a year's accumulated production the current fee was to be levied at DM 22.50 per liter, and for the next 150,000 liters in the same year, the current fee was DM 18.75 per liter, etc.

Interestingly, the agreement contained a special contract concerning the employment of Korean skilled workers. On October 28, 1970 a skeleton contract was concluded between Hanki and M.A.N. providing for the employment of up to 500 Korean skilled workers at the engine and truck manufacturing plants of M.A.N. in Germany.

In line with the agreement Hanki workers began to work at M.A.N. from January 1, 1971.

V. Absorption of Technology into the Company

The production of engines started in May 1975, but the initial production depth was rather shallow until the second stage of construction of production lines for crank shaft, cam shaft, and connecting rod manufacture, which was completed in March 1976. The engine plant was designed to produce 24,000 pieces per year according to the advice of the German consulting firm, Aktiengesellschaft für Entwicklungsplanung (AGEPLAN), which assumed the feasibility study of the project. The actual volume of production for this operation from 1975 to 1979 is shown in Table 1 :

Table 1 Production and Sales Figures(unit : pieces)

	1975	1976	1977	1978	1979
production	1,120	2,578	9,385	15,206	16,200
sales	285	3,119	9,313	15,041	16,144
defective(%)	30.75	27.15	20.45	15.42	12.50

In 1975 there were three major automobile manufactures in Korea. However, they were reluctant to use the diesel engines that Hanki produced. They had several reasons for this. First, they had no confidence in the quality of domestic engines as they were already having trouble with the quality of other automobile parts which had been supplied to them domestically. Second, there was insufficient or even negative price incentive to use domestic engines. By negative price incentive, we mean, that the price of domestic engines was higher than of those imported. This negative incentive phenomenon prevailed not only with engines but also with most other machinery products. The reasons for the phenomenon were as follows : (1) Because of insufficient market size, economies of scale could not be achieved in production ; (2) Parts and raw materials which were needed for the domestic production of a machinery product were imported from abroad at very high cost (due to the small order quantities, cheaper prices could not be negotiated) ; (3) Because of the high debt-equity ratio of the firm, the price of their products included a larger burden of interest costs than did their competitors in advanced countries ; (4) Costs incurred due to inexperience and lack of technology also had to be added to the price of their products. For these reasons, domestic machinery products were naturally more expensive than foreign parts.

VI. Assimilation of Imported Technology

Furthermore, there were technical problems that had to be overcome for Hanki's engines to actually be mounted on automobiles. Engines are not end products by themselves: an engine is a subsystem of a bigger system. Be-

tween a subsystem and its higher system, there always exists a certain degree of interdependence. In order for an independently designed and manufactured engine to be mounted on a vehicle, numerous technical problems must first be resolved so that the two can be integrated into a functioning total system. However, Korean automobile manufacturers had already been producing trucks and buses with imported foreign engines prior to the introduction of Hanki motors in 1975. Thus, it was not immediately possible for the Hanki engines to be mounted on domestic vehicles. The licensing agreement contained no clauses nor did it mention anything about this adaptation problem. It was apparently a planning mistake for Hanki to have overlooked such a basic and yet critical consideration.

In summary, due to confidence gaps, negative price incentives and adaptation difficulties, the engines Hanki produced in 1975 could not establish a niche in the marketplace. Consequently, Hanki began to face insurmountable financial difficulties and eventually was placed in receivership by the government-owned Korean Development Bank which was the company's major creditor.

In response to this (evolving) situation the Korean government began to seek a private firm with sufficient managerial and technical competence to solve Hanki's problems. In February 1976 Daewoo Corporation was selected to fulfill this role and was persuaded by the Korean government to take over Hanki.

Having bought a controlling interest in Hanki, Daewoo corporation changed Hanki's name to Daewoo Heavy Industries company(DHI) and began to focus its attention on solving the firm's problems. The first of the major steps taken by Daewoo was to ask the Korean Government to impose a ban on the importation of foreign-made diesel engines into Korea. The Korean Government accepted Daewoo's proposal on the condition that the price of DHI's diesel engines would be subject to Government control.

At the same time Daewoo launched a project to work out the mounting problem. First, Daewoo's project team worked in collaboration with the Korean Institute of Science and Technology(KIST), a research institute established by the Korean Government to help business firms solve technical problems. Also in case technical problems required deeper knowledge and experience, Daewoo asked M.A.N. for assistance. In the beginning, M.A.N.

was reluctant to provide extra assistance which had not been included in the licensing agreement. However, after repeated requests from Daewoo, and having learned about the serious market difficulties that had resulted from the mounting problem, M.A.N. began to aid Daewoo. After a year of hard work, Daewoo finally succeeded in resolving most of the problems related to mounting their engines on buses, trucks, and other heavy-duty vehicles manufactured in Korea.

VII. The Diffusion of Imported Technology

The diffusion of imported technology took place in two different forms. One form was the diffusion of technology to firms that were competing with DHI, and the other was to other firms which supplied inputs to DHI.

Diffusion to the competing firms took place through DHI engineers who were tempted to move to competing companies with promises of salary increases and promotions. At the time when DHI built its first diesel engine plant in Korea there were no domestic competitors involved in diesel engine manufacturing. However, Hyundai Motor Company in Ulsan Korea, began to prepare to enter this field only a couple of years after DHI started its operation. Engineers were vulnerable to inducements from the competing firm. One piece of evidence which suggests that the movement of these engineers resulted in the diffusion of technology is the fact that when they moved to another company, these moves to other firms were not made by individuals, but, rather, by entire teams of employees who had worked together at DHI. These mass movements of employees to competitor companies were quite common during the boom years of 1975 through 1978, and such losses were extremely detrimental to the sound accumulation of technological capabilities within the firms. During this period, there were even legal disputes in which firms accused one another of "technical manpower robbery," sometimes using blue prints to show how the 'burglary' worked and impacted the firm.

Diffusion of technology to firms who supplied components and parts to DHI came naturally. This kind of diffusion might be described as forced diffusion. The special characteristic of such diffusion is due to the very nature

of machinery manufacturing. A machine is the result of assemblage of parts or components which function together systematically to perform a specified job. There are so many parts involved in a machine that it is neither technically nor economically feasible to manufacture all the needed parts within the firm which produces the machine. Thus, even in industrially advanced countries, the structure of the machinery industry is based on coordination and cooperation among a large number of firms.

Furthermore, due to the systematic nature of machines, that is, as machine components or parts function together systematically to perform a specified job, the quality of a machine depends very much on the quality of each and every functioning part. Because of this systematic nature, the theory of economy of specialization should be observed. DHI believed in the theory and established a program for coordination and cooperation with small machinery firms on a stable and long term basis. This movement was also in line with government directives fostering programs for the localization of materials, equipment and parts. These programs achieved a reasonable degree of success and made significant contributions to cost and foreign currency savings.

VIII. Findings and Conclusions

An interesting finding from the analysis of this case is that the employment contract which was concluded in 1970 between Hanki and M.A.N., stipulating the employment of Hanki's skilled workers at M.A.N.'s manufacturing plants in Germany, played an important role in the absorption of the imported manufacturing technology for diesel engines. According to the contracts, 350 technical operators from Hanki were sent to Germany. On expiration of the employment contract, they returned to Korea to resume their work at Hanki. With the experience and practical training they obtained in Germany, they played a decisive role during the operating stage of the newly imported production facilities.

Analytically speaking, this kind of employment contract is different in nature from a normal training program in three aspects : (1) The large number of trainees involved ; (2) The two year period during which Hanki

employees worked in Germany was much longer than the standard training programs ; (3) The trainees were paid and treated as if they were employees of M.A.N during their placement.

This kind of employment contract program was made possible by the willingness of the technology-supplier to accept such a large number of people as their employees for this period of time. In the case of Hanki and M.A.N. this arrangement was possible because in the early 1970's, Germany was beginning to experience a serious shortage of skilled workers.

In addition to the employment contract for skilled manpower, Hanki took full advantage of an engineers training program that was prescribed in the licensing agreement. More than 30 engineers were sent to M.A.N. in Germany to obtain technical training in relation to the manufacturing processes involved in the production of diesel engines. Thus, because of the intensive and extensive formal and "on-the-job" training which they received in Germany, the Korean skilled workers and engineers who were temporarily employed or trained by M.A.N. in Germany were able to play the most important roles in absorbing the imported technology during the start-up, operation and maintenance of the imported facilities.

The evidence that this approach to introducing new technology led to rapid absorption is convincing. Production volume steadily approached the output level planned in the design capacity of the plant while simultaneously the rate of defective items per 100 declined rapidly and dramatically as can be seen in Table 1.

During the latter half of the 1970s, the Korean economy grew at a rate of more than 10% annually while real industrial growth averaged about 30% per annum. Total transport volume rose rapidly during the same period, and the nation experienced sharp shortages in trucks and buses. However, due to the restricted production capacity of vehicle manufacturers, the shortage problem remained unsolved until the 1980s. The sales volume of diesel engines was stalled at levels far below the volume initially forecast.

Another conclusion from the case analysis is that without a continuous and stable demand for products, it is impossible to sustain continuity in the utilization of employees in technical activities related to product manufacture. Further, when the continuity of men engaged in the technical activities is broken, the continual accumulation of the technical knowledge is seriously

hampered. During the earlier stages of diesel engine production there was insufficient demand in the market for the engines. Therefore, competent engineers who were employed in the diesel engine project were transferred to other projects. The company could not afford to keep these human resources dedicated to a project in which they were losing money. In most developing countries even large companies lack the financial strength to retain highly-paid technical engineers simply for the purpose of accumulating technical knowledge when a project continues to operate in the red. Thus, initially the absorption of imported technology was quite rapid during the earliest stages of the project, but the absorption of knowledge beyond the production stage was unstable because of the instability of involvement of both engineers and technical employees. As a result, when the company wanted to modify or improve the products, such as power-up, power-down, reduction of weight, etc., they again were forced to seek technical assistance from a foreign licensor rather than develop such innovations and improvements through internal research and development. Thus the company was forced to secure the assistance of Isuzu and Toyota of Japan as new technical collaborators when efforts were made to build smaller diesel engines in 1977.

The company has now grown to comprise four major plants : an industrial machine plant, a diesel engine plant, a rolling stock plant, and a precision machinery plant. The company has launched ambitious projects in heavy machinery areas including engineering services and plant sales on a turn-key basis throughout the world market with annual sales of US \$1 billion as of 1992.

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