TECHNICAL INFORMATION AT LARGE AND ITS UTILIZATION FOR THE DEVELOPMENT OF TECHNOLOGY

- A Case in Food Processing Industry -

Suck-Chul Yoon
Professor of management
Seoul National University

1. Introduction

This article analyses a case in which a business firm in a developing country collected technical information from an industrially advanced country and utilized the information for the development of it's own technolgy. Business managers and economists generally agree that the development of technical capabilities is the most powerful way for a business firm to be successful in the market. However, there exist two major barriers on the way to technology development: the first barrier is that the development of technology is expensive; the other is that the development of technology involves a high degree of risk, that is, the success is not guaranteed. Because of these two barriers, small and medium sized firms, particularly in developing countries, have difficulties in solving their technology problems.

This article presents a model for a financially frail firm in a developing country to develop their technology by taking advantage of free information from advanced countries. To a certain degree, technical information is at large, and information has a tendancy to diffuse like free air in nature. Indeed, informative hints or technical clues abound in great quantities in industrially advanced countries. Furthermore, there are few clear lines of demarcation separating the information as free goods and information as property rights. In this article, I shall not address the relationship between the two types of information. Instead, I shall analyze a case of natural diffusion of technology from an industrially advanced country to a developing one.

The case concerns a successful food processing company in Korea. The name of the company will be disguised as courtesy to the company. I shall call the company Foodco. Foodco was established in the 1960s in Korea as a snack manufacturer. Since its foundation Foodco has actively introduced innovative new products into the processed food market in Korea. The company has grown into a large and leading one in its field.

2. Planning of A New Product

Up to the early 1970s, when Korea's per-capita GNP was below $300, "off-the-meal" snacks for Korean children were quite limited. The only available snacks were what was then called "kwa-be-gi", sweetened fried flour bar twisted like rope, and candies from variety stores. Fried Kwa-be-gi, however, easily dirtied the hands and clothes of the children with oil, and sometimes caused stomach trouble when over eaten. Candies containing too much sugar were also believed harmful to the teeth and appetite of the children. Besides these two types of snacks, Korean children were then fond of "twi-bab", that is, popped rice burst out from a popping machine operated by individual street vendors. However, the self-sufficiency ratio of rice, the main staple for Korean diet, was only about 60 percent during that era. Thus, the Korean government tried to discourage the consumption of rice, while encouraging the consumption of wheat flour.

Foodco reasoned that there would be a bright prospect for snacks based on the process of "popping" using wheat flour as main substance instead of rice. Foodco also attempted to enhance the taste and nutrition of the wheat flour by adding fresh shrimp trawled in large quantities from the coastal seas of Korea.

3. Search for Technical Information

Foodco, however, had few ideas about how to convert the small popping machines of street vendors into a process capable of mass production. Foodco decided to search for technical information from countries with advanced food processing technology. The country in which they chose to travel was Japan. In Japan they came across many kinds of snacks which seemed to have been produced by a "popping" process.

After several days of search, they met a professor majoring in food processing technology, and learned from him that there existed a "parching technology" in which salt used as a medium for heat transfer. According to the parching technology, pieces of dried dough of wheat flour are passed through a rotating drum containing heated salt. Foodco also learned that a machinery manufacturer named Yamamoto Machine Co. of Japan provided such parching machines. Foodco visited Yamamoto Co. and ordered the machine.

The machine was imported and installed at Foodco in October 1970. However, the machine did not produce satisfactory products. Foodco asked Yamamoto Co. for help. But even Yamamoto was not acquainted with the detailed process necessary for satisfactory production. Yamamoto was a hardware maker, not a snack producer. They were making hardware facilities on orders received from the snack makers.

Foodco knew that their problems would be solved easily if it entered into a technology transfer contract with a firm producing snacks using the parching technology. However, Foodco could not afford financially to pay for royalties and licensing fees. Thus, Foodco decided to undertake a long series of trial-and-error experiments until satisfactory products emerged.

In the meantime Foodco visited Japan from time to time, and searched for retired engineers who once had worked for a snack manufacturing company. Here and there, Foodco received bits of information and arrived at four important variables affecting the quality of expansion of dried dough pieces: (1) the percentage of protein contained in the flour, (2) the percentage of moisture contained in the dried dough, (3) the temperature of salt in the rotating parching machine, and (4) the length of time for the dough sticks to pass through the machine.

4. Experimental Efforts Came to Fruition

Foodco's experiment team was determined to ascertain the right combination of values of the four variables. They carried out hundreds of trial and error experiments by varying the values of the variables. Foodco's experiment team worked day and night, slept and ate on mattresses under the machine in the company. Their effort resembled that of Thomas Edison when trying to discover the right material for a filament of incandescent electric lamps. They were so absorbed in the experiment that they failed to differentiate Sundays from ordinary week days.

Despite the fact that the trial-and-error cost exceeded the tolerable level of the financially troubled Foodco, the top management of the company continuously supported their experiment team. The managers encouraged the team by saying that "people at Foodco can enjoy the freedom to fail in their pursuit of success for Foodco." Top managers also tried hard to provide the team with the technical information they needed for their experimental success. The information about the four most important variables discussed above was also provided to the team by the top management.

The total quantity of wheat flour spent for those experiments amounted to 80 car loads by 4.5 ton trucks. In December 1971, after more than a year's devoted efforts, Foodco finally succeeded in bringing out the hoped-for snack. "Arikang" was given to the snack as its trade name. Arikang had a delicate savory of shrimp-flavor and did not contain sugar or oil. Arikang became a hit product immediately.

Due to the success of Arikang, the total sales volume of Foodco jumped by 350 percent within 3 months after Arikang was made available to retailers. The average cash-in period of outstanding account receivables also changed significantly. Before the advent of Arikang, the period had averaged 3 months, but following the production of Arikang, the period was reduced to about 20 days. The reduction was achieved because the sales transaction of Arikang was done on a cash basis. Some customers even solicited the purchase of Arikang with cash payments in advance of delivery. Often, when trucks loaded with Arikang approached a local distribution center, interesting scenes came to view. The Arikang-loaded trucks were followed by several bicycles. The riders were local retailers, and they followed the truck in order to guarantee delivery. They also thought that if their stores ran out of Arikang, they would loose the goodwill of children customers. The resounding success of Arikang enabled Foodco to expand and invest further for other new products.

5. Absorption of the Technology

When the parching machine was imported from Yamamoto machinery co. in 1970, Yamamoto refused to give Foodco the drawings of the machine. Hence, Foodco had to learn about the internal structure of the machine when they opened up the machine for repairs and maintenance. After two full years of such effort, Foodco ended up with complete drawings of the machine. Once the drawings were made, it became possible for Foodco engineers to make replicas of the machine for their own use. Thus, in 1972 Foodco engineers succeeded in making three copies of the parching machine. These replicas were, in some ways, better than the original machine. Taking advantage of their past experience obtained while repairing trouble-making parts of the original machine, Foodco engineers succeeded in modifying and improving the troublesome parts. These replicas were successfully put to use to meet the growing market demand of Arikang.

By 1979, Foodco engineers succeeded in making an enlarged version of the parching machine raising the production capacity of the machine from 400 Kgs to 600 Kgs per day. The success at this time was based largely on a method of trial and error. But by 1983, when Foodco manufactured five more sets of the machine, raising the production capacity to 1,000 Kgs per day, they utilized mathematical formulae to calculate the desired values of various dimensions of the machine needed for the increased production capacity.

6. Improvement of the Technology

About two years after the birth of Arikang, competitive products began to appear in the market and negatively affected Arikang sales. Foodco tried to counter the challenge by improving the quality of Arikang.

Up to that time, the insert operation of dried dough pieces into the parching machine was done by manual batch method. Foodco engineers thought that the manual method should be replaced by an automatic mechanical system which could feed the dried dough into the parching machine with a uniform rate of speed. Uniform speed was needed to attain uniform quality of the products. Foodco engineers solved this problem by setting up a vibrating and inclined duct system through which raw dough sticks were introduced into the machine. By this automated insert method, the productivity of the process was improved, but the problem of uniform quality was not perfectly solved. Among the products, were pieces that were burnt too much, and pieces that were toasted too little.

The persistent presence of these defective pieces indicated that pieces in the parching drum were unevenly exposed to heat. Foodco engineers set out to locate the source of the problem. One of the engineers crept into the machine with the heating system off and investigated how salt and dough pieces mixed and moved together when the machine was in its rotating motion. He discovered that the degree of exposure to heat could vary depending on the location of landing of input pieces. In 1975 he developed a modified landing system of dough pieces, and the problem was solved. With this modification, the quality of Foodco's products were enhanced far above similar products competing in the same market.

In 1978, Foodco accomplished another technical breakthrough enabling further improvement of the technology and its products. The longer the salt was used as a heat-transfer medium in the parching machine, the blacker the salt became. This blackened salt, in turn, caused the color of the products to be darker than Foodco designed. Thus, engineers had to replace the heat-mediating salt with new salt every week. But even with frequent replacement, a lapse of one or two days would produce black particles on the surface of Arikang, making the color unattractive. This problem concerned Foodco for two reasons: one was the concern for productivity, and the other was the quality of the product.

When and where did so many black particles come into being? Foodco engineers struggled to determine the cause of the problem. After a series of heated discussions, Foodco engineers concluded that the black particles derived from dough powders. Prior to the parching process Foodco used a drying process in which dough sticks were dried up to a certain degree of aridity. In the drying process, dryer machines rotated with dough sticks in them. Dough powders were generated by collisions of dough sticks against each other. When exposed to heat in the parching machine, the powders were carbonized into black particles, which contaminated both the products and the salt. To solve the problem, Foodco engineers inserted a vibrating sieve near the end of the duct through which dough sticks were transferred to the parching machine. With this application of the sieve, they eliminated the need to change the salt, and Arikang maintained its originally-designed color with a high degree of consistency.

Both alarmed and encouraged by Foodco's success, more and more rival firms rushed to supply the market with similar products. Knowing that the only way they could maintain their leading edge in the market was to push ever further ahead of their rivals in terms of product quality, Foodco expanded its efforts to enhance Arikang. For example, in 1979 Foodco conducted a sample market survey of their own products. Foodco found that packets of Arikang contained too many crumbs. When and where did the crumbs come into being? After a thorough search, they found that the crumbs were generated during their packaging operation. At that time, because Foodco could not afford to purchase automatic packaging machines, they hired hundreds of workers to put Arikang into packages using iron scoops. Foodco believed that the scoops were responsible for the production of so many crumbs. They concluded that the only way to solve the problem was to throw away the iron scoops and put Arikang into the packet by use of hands. This alternative was adopted, but, as time passed, the workers' fingertips became sore and damaged. Foodco's response to this problem was to invent rubber finger tips. Years later, when Foodco became financially more secure, they purchased automatic packaging machines.

7. Assimilation of the Technology

Up to 1983, oil burners were used to heat the parching drum. However, oil burners emitted soot and smoke and thereby polluted the air inside the plant. Foodco decided to replace the oil burners with LPG gas burners. Another improvement was made with regard to working conditions around the parching machine. The parching machine had been installed on top of heat-resisting bricks. This brick structure caused two kinds of problems. One was that it was not movable to other locations when needed. Another problem was that bricks radiated so much heat that the room temperature became uncomfortable, especially in warm weather.

Foodco eliminated the bricks and adopted a stainless steel frame structure instead. At the same time, they utilized heat- insulating materials to shield the machine and minimize the amount of radiated heat. With this modification, both the problem of immovability and heat radiation were solved simultaneously, and a side benefit was that the new structure was aesthetically more pleasing.

In 1988, Foodco engineers succeeded also in reducing the noise level of the machine. Vibrating sieves were installed to strain out dough powders as discussed earlier. Those sieves were designed to vibrate by virtue of a crankshaft mechanism which unfortunately generated a great deal of noise. Foodco engineers removed the crankshaft and adopted a new system operated by what they called electrical impact system. The new system reduced both the noise level and energy consumption.

Owing to improvements in working conditions, such as room temperature, noise level, and cleanliness of the air, the hitherto unpopular parching workshop was converted into a work place with high popularity among employees.

More than 20 years have elapsed since the birth of Arikang, and thanks to incessant improvements of both the parching technology and its products, Arikang still remains one of best selling snacks for children in Korea. After the success of Arikang, a series of "Kang" products such as Kamjakang (made of potato), Yangpakang (made of onion), and Kokumakang (made of sweet potato) were added to the line of products to achieve the economy of scope of the parching technology. As a result, the "Era of Kang Series" emerged in Korean snack history.

8. Findings and Conclusions

There is a Korean proverb which says that "It takes more than pearls to make a necklace". Pearls scattered around do not serve any good purpose. Likewise, we can say that a successful technology is the result of systematically organizing its constituent elements. Where are the constituents of a technology scattered around? To use the parlance of technology research, we adopt the term 'embodied' instead of 'scattered around'.

Apparently there are technologies which are embodied within human muscles. Technologies which require years of training to attain dexterity belong to this category. It may be more appropriate to call this category of technology "technical skills". In the economic development of a developing country which abounds in labor forces, this category of technology might be the first one to develop. In industries such as garments, machinery and equipment manufacturing, which require high level of manual skills, this category of technology plays an important role. Korea's earlier success in economic growth belongs to this case. During the past decades Koreans have earned innumerable gold medals in the international competition in this category of technology. In the case of Foodco, however, this category of technology did not play a significant role.

The technology upon which Foodco relied is of another category, one which is embodied in hardware, that is, production facilities or machines. Technologies embodied in hardware can be transferred easily from an advanced country to a developing one through the purchase of the hardware. In the case of Foodco, parching technology was first transferred from Japan to Korea through the purchase of the machine. However, the transfer of hardware-embodied technology was not enough for the production of the aimed products. For up to one year after the installation of the parching machine, Foodco could not produce satisfactory products. Hence, there must be a third category of technology which is embodied somewhere else.

In the case of parching technology, knowledge, such as the percentage of proteins in the wheat flour, the degree of aridity of the dough sticks, the time required for the sticks to pass through the parching machine, and the temperature of salt in the parching drum, etc. would belong to this category of technology. Since this third category bears strong intellectual characteristics, we may call it "technical knowledge" or "know how". This category of technology must be embodied in the human brain. Some of these knowledge-type technologies may well be stored in the form of books, blueprints, programs, formulae, etc. But knowledge contained in these types of 'containers' must be finite in nature, while knowledge required for real-world production is infinite. Thus, satisfactory level of a technology cannot be transferred easily. It should be attained only through endless efforts on the production floor. The case of Arikang realistically advocates this truism.

The process of trial and error effort is expensive. Many firms in a developing country are financially weak. They cannot afford to develop expensive technologies without short-term returns from them. In other words, technology has little meaning to them unless the products of the technology sell well in the market. Thus, business enterprises in a developing country should pursue the development of their technology in parallel with the development of proper concept for its product. Let's call this process 'parallelism' in development of technology.

The parallelism can be summarized as follows. (1) A clear market need should be recognized first and a thorough definition of attributes of a product to satisfy the need should be made. Next, (2) those attributes should be incorporated into the design of the product to be produced. (3)

The designed concept of the product in turn should serve as a guiding light in searching for an appropriate process technology to produce the product. The search for the process technology would result in (4) a purchase of hardware incorporating the process technology. There could be cases in which the hardware alone would be sufficient for the production of the envisioned product. Otherwise, (5) additional search for more information about the process should follow in order to identify important variables playing major roles in successful production. Once the variables are identified, the next step is to (6) dedicate ceaseless efforts to find out the values of those variables through trial-and-error experiments. These six steps, followed serially, account for Foodco's success.

Until the advent of Arikang, Foodco had registered deficits year after year. Arikang not only rescued Foodco from its financial crisis, but also provided the firm with the financial resources needed for the further development of new products and expansion of facilities. Arikang, entering its 22nd year on sale in Korea as of 1993, still sells well, earning about 30 million US dollars worth of sales every year. One solid success of Arikang in parallel with a new technology to produce it was just enough as a starting point for the company to diversify into other products. During the 20 years after the success of Arikang, Foodco continued to successfully produce more than 50 other new products. As a result, Foodco has become a solid leader in its field with more than 700 million US dollars worth of annual sales of processed food.

Suppose Arikang had turned out to be a product which received only a mediocre response in the market. The development of the parching technology alone, however successful it might have been as a technology, would not have contributed so significantly to the success of the company. In fact, we have heard of many cases in which developement of a new technology was unsuccessful. However, a deep and thorough investigation into the cases might reveal that the management's failure in pursuing the parallelism as discussed above was reponsible for the failure of the technology. The six steps as pursued by Foodco could serve as a model for financially infirm companies in a developing country to emulate for their development of technology.

REFERENCES

※Major sources of information of the article were internal documents and interviews with emmployees of the company in concern

National Bureau of Statistics, Social Indicators in Korea, Economic Planning Board, Republic of Korea, 1992

Korea Institute for Industrial Economics & Trade, The Evolving Structure and Characteristics of the Global Technology Market, papers and proceedings of the International Seminar held 12-12, January, 1993, Seoul, Korea.

Yoon, Suck-Chul, Principia Managementa, Kyung-Moon Sa, Seoul, Korea, 1991.