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Learning Process of Core Technology in Sporting Gun Industry of Japan

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Abstract: Japanese sporting gun manufacturers have competitive advantage in the world market. The unfavorable conditions after World War II resulted in improving the sporting gun processing technology drastically, during which the core technologies and their learning process have shifted in four phases.

Keyword: learning process, improvement in quality, competition and selection

1. Introduction

Sporting gun is for sport and hobby of private use, not for military. In present Japan, the sporting gun industry is not known as an industry having the competitive advantage in the world market. However, Japanese sporting gun manufactures produce 200,000 or more sporting guns annually, and 99% of these are exported.

Nevertheless, sporting gun industry of Japan grew up under a seriously adverse market conditions:

1) Market in Japan is extremely small.
2) There exist law regulations of the arms export from Japan.

In Japan, the law prohibits any kind of export to military forces, Communist bloc, and countries in civil war. The export procedure to safe countries is also very severe.

These unfavorable conditions of domestic and foreign market suggest that the competitive advantage of Japanese sporting gun manufacturers is in their technology.

In the prewar time, most of sporting guns sold in Japan were imported from United States and European countries. Japanese commercial sporting gun manufacturers were very small even though there existed large military arms manufacturers. The large military factory adopted division of labor and

mass production by using compatible parts and modern machines. However, the small-scale private sporting gun manufacturers employed few craftsmen and adopted the custom production system in which each craftsman took charge of allover process.

The differences between such workmen's type and production methods made it difficult to transfer technology and human resources from military manufacturers to private sporting gun manufacturers.

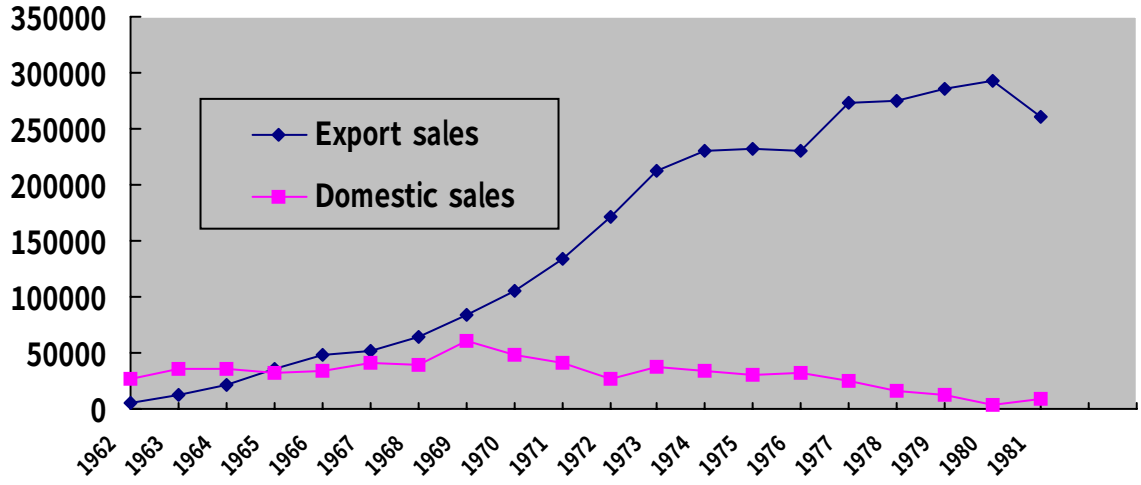
Moreover, the process technology of sporting guns has once died out after World War II. In 1946, GHQ prohibited the possession of firearms and gunpowder. Manufacturing firearms in Japan had virtually stopped, that is, the sporting gun industry and its technology had been discontinued at that time.

In 1951, ban on manufacturing of the sporting gun was lifted. Afterwards, in a short term of about ten years, Japanese sporting gun manufacturers had been developing the process technology to export their guns.

In United States and European countries, hunting and shooting have a very long history as a hobby. The numbers of consumers are large, and the law regulations are very loose. Many manufacturers produce both military gun and sporting gun. The technology accumulated for military use have often been transferred to the private sectors.

The purpose of this study is to clarify the surviving process of Japanese sporting gun manufacturers against U.S. and European manufacturers which had such competitive advantages. In this paper, the period 1950 to 1970 are divided into four phases. Between phases, the core technologies in the point of competitive edge had shifted, and also the learning process of the core technology have changed.

Figure 1. Number of Sales of Sporting Gun Manufacturers



Source: *Tsusansho Kikaitokei* (1962-1981).

2. Development Process of Sporting Gun Industry in Japan

In 1951, the government and GHQ lifted the ban on small arms production. In the 1950's there were over 10 manufacturers in Japan, and manufacturers who won in Japanese market began to export and grow. Export including OEM exceeded 50% of the whole quantity of production in 1965, and exceeded 90% in 1977. Many manufacturers withdrew after the 1970's and only three companies, Miroku Firearm Mfg., SKB, and Kodensha, survived. By the revision of gun regulation law, firearms possession was restricted and eventually domestic market shrunk. Consequently, this strengthened export pressure and improved the learning process of core technology.

Here, the development of sporting gun industry is divided into four phases and the reason why the core technology became the key to the survival in each phase is explained.

Phase 1: After the war, in 1950, Gun and Sword Control Law (the government ordinance No. 334) was instituted against the increase of demand for hunting and hobby. First, the government permitted only possession and manufacturing license of the air gun. The sporting gun manufacturers often entered the market by air gun manufacturing which barriers to entry were low. Legal permission and advanced technique was not necessary for air gun manufacturing, therefore, new entry in the air gun market was easy. Besides, license was not necessary to possess an air gun though license was necessary to possess a sporting gun which used gunpowder. There were a lot of air gun holders because they were easy to possess. However, the law was changed in 1955, and license was made necessary for possession and manufacturing of air guns. The number of air gun holders decreased sharply.

Phase 2: After the legal restriction had been placed on air gun possession and manufacturing, some manufacturers shifted from air gun manufacturing to sporting gun manufacturing. Upon this shift, the most important technical key was the machining technology: especially the super deep hole processing which is a peculiar machining technology in firearms manufacturing. Manufacturers who could not acquire this technology were weeded out. The engineers in sporting gun manufacturers acquired the manufacturing know-how through repeating trial and error. Nevertheless, much of Japanese sporting gun product remained as mere imitation in shape and their product had not yet reached international standard. The quality of the product had not been stabilized and troubles were frequent. Yet, in the disadvantageous environment where machine tool, material, and information from foreign countries were scarce right after the end of the war, they have improved their products continuously to supplement shortage. The effort produced innovative processing technologies which would exceed U.S. and European manufacturers in the following period.

Phase 3: In the 1960's, Gun and Sword Control Law

Figure 2. Four Phases and Core Technologies of Technology Learning Process

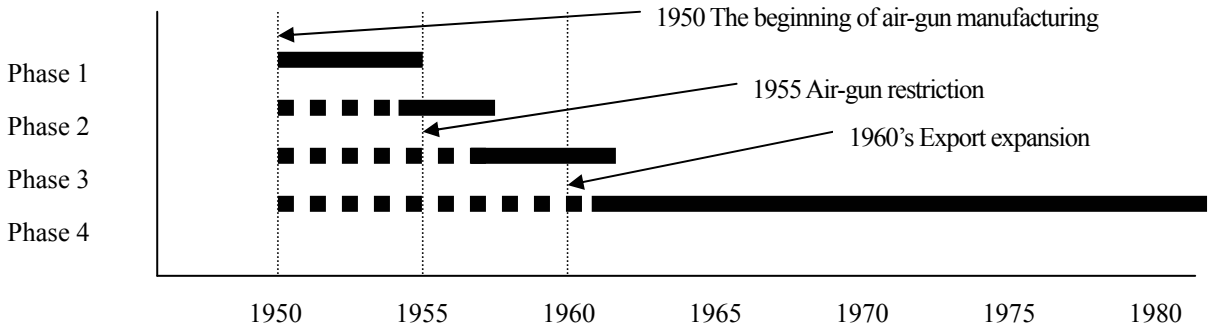
Phase		Core technology	Learning method
Phase 1:	Overabundant air-gun manufacturers	None	None
Phase 2:	Selection to sporting gun manufacturers	Machining	The engineers' trial and error
Phase 3:	Sporting gun manufacturing know-how accumulation	Heat-treatment	Feed back from network of consumer and retail store
Phase 4:	Export expansion	Hand finishing	The craftsmen's skill.

was revised several times in Japan. Domestic market has rapidly declined by 1969; the peak year of restriction, thus making the sporting gun manufacturers shift to markets in foreign countries. There is a severe safety standard on the firearms (C.I.P., SAMMII, etc.) in foreign countries. This safety standard must be cleared in order to export sporting guns. Supplying products of high quality and stability was especially important. Main problem with the quality at that time was the degradation (hardness lowering, etc.) of the material in heat treatment processing (quenching, annealing, welding, and soldering). This is not a physical trouble as processing accuracy of parts but a chemical trouble such as changes in the material during heat-treating. Such chemical problems arise in the slightest difference of condition (temperature, etc.) in manufacturing. Though physical defect is easily understood, chemical defect is hard to confirm: Discovering and understanding are difficult.

The manufacturers collected trouble reports from the network of customers, repair agents, and retail stores. They accumulated the know-how of the product. The problem of heat-treatment was gradually solved. However, manufacturers who could not solve these problems were weeded out.

Phase 4: Certain manufacturers, Miroku Firearm Mfg., SKB, and Kodensha, who have overcome the accuracy of the machining and the problem of heat-treatment grew by transferring the market from domestic to foreign countries. At this time, they needed not only physical and chemical high performance but also sensuous one. This is an additional value that satisfies customers more than the performance in numerical value. Virtually, this is the finer tuning, the design, the fitting, and the feeling when shooting it: In a word, this is the taste. Excellent performance in numerical value does not disappoint consumers, yet they will not be satisfied either. Machining cannot create the taste of the product.

Figure 3. Timeline of Technology Learning



3. Evolution of Quality Control and Core Technology Acquisition in Each Phases

The know-how in three core technologies, namely, machining, heat-treatment, and hand finishing, had been brought together. The machining was acquired in the shortest period, however, the hand finishing took the longest time to reach satisfactory level. The length of time required for the acquisition of these technologies depended on their Difficulty Level of acquisition. As a result, technologies that became cores in each phase shifted from one technology to another.

The manufacturer can easily discover a defect in machining by pre-shipment inspection because a defect is a physical problem. Therefore, manufacturers can improve this the earliest and also acquire technical knowledge most easily.

However, a defect in heat treatment is a chemical problem and discovery is harder. Manufacturers might not be able to discover defects by pre-shipment inspection. Practically, manufacturers are not able to discover a heat treatment defect until the consumers use the products under various conditions; in other words, until the product had been out to the market. A system which could pick up voices from consumers is necessary. Information on the defects of the product was fed back to manufacturers via repair agents and retail stores, though still, it was not easy to discover a defect of this kind.

The hand finishing and fitting by the craftsmen gives the product sensuous value. Refinement in the technology of such hand finishing was important to withstand severe market competition. Nevertheless, discovering and understanding technical problems in the hand finishing was even harder. A product with a bad finishing is insufficient, though it is not a defect.

Neither consumers nor manufacturers could easily notice an improving point. Besides, both the consumers and manufactures need to possess an understanding of the taste of the gun. As delicate adjustment is required for the quality control on the customers' favor, the task required highly skilled workmen.

The difference of these processes resulted in the

difference of time it took each core technology to be acquired.

4. Adversity of Japanese Market and Feature of Technological Acquisition Process

The sporting gun industry in Japan was in a very painful adversity in respect of legal restrictions and the market. However, Japanese sporting gun industry overcame the obstacles by obtaining high technical strength and developed itself as an export industry.

At first, manufacturers in Japan acquired the processing technology by reverse engineering of overseas products, that is, they started by imitating overseas products. However, Japanese manufacturers acquired competing technology with overseas manufacturers within ten years time.

The Japanese manufacturers in postwar period lacked material with good quality and excellent machine tool. In order to raise the quality of their products, they were forced to make an effort in fields other than the performance of the material and machine. They improved the processing technology and invented efficient and innovative technologies. Japanese manufactures' inventions were a fruit of unfavorable circumstances.

Reverse engineering is an effort to read the manufacturing process from end products, then to draw blueprints, and to reproduce the products. Nevertheless, a complete imitation would be impossible. Some processes are reproduced only by guess. The Black Box of technology exists. Japanese manufacturers applied reverse engineering and filled in the Black Box in technology, whose manufacturing method, surprisingly, has exceeded original overseas production method.

Japanese manufacturers made improvement in order to supplement lacking resources. This, however, made it possible for them to adopt innovative and reformative technology without sticking to the old manufacturing method, because the knowledge of production technique was scarce. The technology of Japanese manufacturers developed owing to adversity of shortage in resources.

5. Conclusion

This paper divided the development of the sporting gun manufacturers in Japan into four phases and analyzed the core technologies which were the keys to competitive edge in each phase. In addition, this paper showed that technology acquisition and improvement in quality resulted in selection in the Japanese sporting gun industry. The degree of difficulty in discovering the products' defect is greatly related to the Difficulty Level of improvement.

In the sporting gun industry, there were three core technologies. Discovery and improvement were harder to achieve in the following order: hand finishing (sensuous), heat-treatment (chemical), and machining (physical) technologies. As a result, it took the manufacturers more time to acquire more difficult technologies according to Difficulty Level.

Acquisition of the core technology and improvement in quality control brought about competition and selection in each phase.

Sporting gun industry in Japan developed under a seriously unfavorable condition. The adversity caused manufacturers to weed out, however, it also gave birth to innovative technologies in return. This became a powerful source of competitive edge against overseas manufacturers.

In Japan, the sporting gun industry had started as small businesses and its history is rather short. They had to acquire sporting gun processing technology from zero. This paper draws the learning process of technology the hand finishing, the heat-treatment, and the machining technology, which are the peculiar technologies in firearms manufacturing. Yet, when we paraphrase these terms as sensuous, chemical and physical technologies, the differences of each technology is similar in other industries, too.

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