Technological Innovation and International Competitiveness of Die and Mold Industry in Taiwan and Korea

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Preface

Dies and molds are indispensable tools for mass production, for example of electric & electronic products, automobiles and motorcycles. The many parts that make up these products are produced using dies and molds. Though the die and mold industry is very important for the development of mass production, developing countries have found it very difficult to develop, due to their lack of skilled engineers and workers.

Since 1998, Korea's exports of dies and molds to Japan have exceeded its imports. Up until 1997, Korea had depended on Japanese dies and molds to produce mass products such as electric & electronic products, automobiles and motorcycles.

Taiwan's die and mold industry is in a state of transformation from an expertise-oriented to an IT-enhanced form. For the past several years, its mold industry has been characterized by its low cost and high flexibility. Despite the fact that most of the firms are small and medium enterprises, the top managers, who have a strong desire to enter the international market, have shown a willingness to contact foreign customers directly or through networks. They have acquired not only the necessary mold fabrication techniques, but also adequate management knowledge. More and more of these companies have moved to Mainland China in order to reduce costs and to develop new markets. At present, their typical work pattern is to take orders in Taiwan, and deliver the products from the Mainland. There are high expectations that new forms of work will develop in the near future to accompany China's entry into the WTO in 2002.

In 2001, Institute of Developing Economies (IDE) organized a joint research project on "International Competitiveness and Management in the Die and Mold Industry in Taiwan and Korea" together with Industrial Technology Research Institute (ITRI) in Taiwan and Korea Institute of Machinery & Materials (KIMM). This joint research has aimed to analyze the factors that have allowed Korea and Taiwan to increase their production value of dies and molds. Before concluding the research project, IDE also held a workshop from 19th to 24th in November, 2001, in Japan. We would like express our deep gratitude to all those who participated in the workshop, and especially to Mr. FUJIMOTO Makoto, Researcher of The Japan Institute of Labour, for giving the presentation on the results of Japanese research.

This report is the final result of the joint project on "International Competitiveness and Management in the Die and Mold Industry in Taiwan and Korea."

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Mizuno Junko

Introduction

This collection of research papers reveals the fact that ongoing drastic changes in the production structure of dies and molds in Asian region are attributed to a shift in the manufacture of dies and molds toward a process industry due to technological innovation, and further the fact that, with installation of advanced machine tools and other sophisticated processing equipment, those die and mold products which essentially rely on the accuracy of such machine tools can be manufactured anywhere in the world, so that the production structure of these products has been drastically changing globally. Under these circumstances, this collection of research papers examines the technological advantages of Japan, the Republic of Korea (hereinafter referred to as “Korea”) and Republic of China (hereinafter referred to as “Taiwan”) in the manufacture of dies and molds, and based on such technological advantages, whether or not it is possible for these economies to differentiate themselves in the manufacture of these products or alternatively, to develop international division of labor.

1. What are Dies and Molds?

Dies and molds are one of the typical capital goods as machine tools, and one of the tools necessary for the modern industries to run mass-production. Customer industries for dies and molds range broadly over transportation machinery, industrial machinery, electric machinery & equipment, household goods, office goods, optical devices & equipment, glass containers, construction materials & equipment, toys and sundries. As these products and equipment consist mostly of parts, units (subassemblies) and components, which are used in volume, dies and molds are supplied virtually to every company manufacturing such equipment, products and parts & components. In terms of industrial applications, dies and molds are classified into press dies, plastic molds, die casting dies, forging & casting dies & molds, powder metallurgy dies, rubber dies and ceramics dies. Web site run by the Japan Die & Mold Industry Association explains: “Dies for press applications are classified into trimming dies, bending dies, drawing dies and

compressing dies, which process materials such as steel sheets and non-ferrous metal sheets, and are used to produce parts and components for automobiles, consumer electric and electronic products, sundries and many other products". Molds for plastics are "classified into such molds as applied for injection molding, compression molding, transfer molding, blow molding and vacuum molding, which process plastic materials and are used to produce parts and components for consumer electric and electronic products, automobiles, sundries and many other products. Molded plastic products are typically used in TV sets, OA equipment and consumer electric and electronic products," as well as in ballpoint pens, PET bottles, lunch boxes and food containers to mention a few.

As dies and molds are capital goods for mass-production, they are rarely noticed outside industrial plants by general consumers, so that dies and molds are tools that are difficult to be discerned in general, unlike implements. In understanding dies and molds and their working, let us think of, for example, a ballpoint pen, a PET bottle, or containers for pudding and yogurt. An ink cartridge of the ballpoint pen, and pudding or yogurt packaged into its container are sold at affordable price, while all these containers are processed or formed by plastics molds. Melt plastic materials are fed under pressure into the cavity, a space formed the inside of a mold, to form a plastic container. As shapes of these containers and parts differ from each other, each container that is different in shape requires its own mold. These molds do not catch the eye of consumers, but without these molds production of containers and parts is impossible. A container or part is produced at a rate in the magnitude of several units per second, and in the production process a mold is incorporated into an injection molder, a process machine, and plastic materials are fed into the cavity of the mold to form a specific container or part. In the case of a vacuum cleaner, a household appliance product, for example, the cleaner is made of some 300 parts, all of which are formed by molds.

As dies and molds help in the fabrication of parts and components, their accuracy determines the accuracy of the parts and components manufactured with them. When the required accuracy of a consumer good for end use is stringent, parts used in the consumer good must be finished with the matching high accuracy, and the molds used to fabricate these parts are required to have much higher accuracy. In the case of aluminum cans that package beverages, their notched tap, if any, poses a danger of injuring the lips of consumers, so that these cans are finished within the accuracy of 1 micron, while the accuracy of the corresponding molds are in the magnitude of 0.1 micron. The good quality of Japanese products has been largely supported by the high accuracy of molds.

2. The Importance of the Die and Mold Industry in the Manufacturing Sector

Dies and molds are integrated by a kind of tacit-knowledge based engineering, and they are of a critical capital good to determine the quality and price of products for end use. Dies and molds are a critical capital good, but the accumulation of experiences are necessary for a country hopeful to newly develop its industrial sector to acquire manufacturing technology of molds, and the build-up of such expertise on dies and molds has necessitated the bringing up of skilled technicians, which takes time and is not so easy.

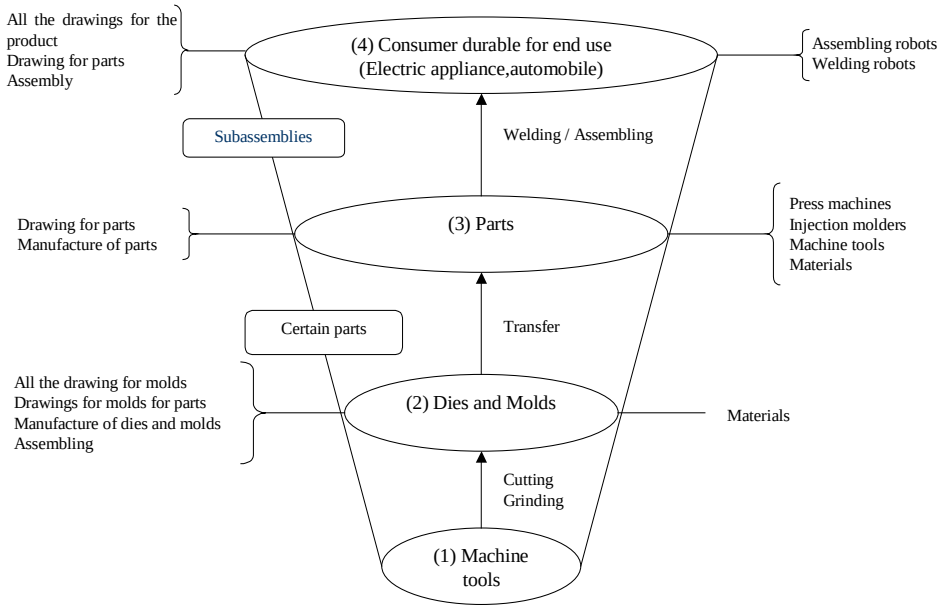
Figure 1 “The Hierarchical Structure of Production Process” shows through what stages technologies are shaped in developing countries. For example, if the consumer durables for end use are smaller cars, a developing economy in Asian region, which launches for the first time the manufacture of smaller cars, starts from assembly operations based on the complete knockdown or semi-knockdown approach, in cooperation with Japan or some other industrialized country. Then, as production volume increases, the developing country begins to run assembly operation using locally produced automotive parts in order to reduce foreign exchange payment on the import of knockdown kits. Local assemblers or their suppliers of these automotive parts, who intend to locally manufacture press-formed parts, for example, may import press dies, press machinery and steel sheets. In other words, in order to locally produce parts and components, they must import dies and process machinery. Thus, an increase in locally produced parts and components results in the corresponding increase in imports of process machinery such as dies and metal-forming machines. This situation enabled Japan to have been a monopolistic supply base of capital goods to these developing economies.

Dies and molds are a cluster of product manufacturing know-how, and at the same time are essential elements in the mass-production process, but as far as an operator of the mass-production process remains dependent on dies and molds supplied by foreign vendors, the operator is not able to produce by himself the product that he wants to manufacture. As a result, demand for die and mold production emerges independently, and thus the operator or his local vendor imports machine tools as the process equipment for building molds. As this case exemplifies, if one determines to manufacture a product by oneself, the person must come down the hierarchic structure of the production process.

Not limited to automobiles, but when a local manufacturer starts domestically producing to a full extent an industrial product that has been manufactured by direct investment from overseas or through technological partnership, the process of such

domestic production evolves a process akin to excavating the hierarchical structure seen in Chart 1 from the top stratum down to the bottom.

Figure 1 Hierarchical Structure of Production Process



Source: Figure prepared by the author.

The domestic manufacture of molds requires capital goods (machine tools as process machinery) and such production goods as raw materials for molds as well as parts and components of these dies and molds. Moreover, in order to build these molds, besides sophisticated process systems, master engineers and skilled technicians specializing in mold manufacture are also required. But, in recent years, machine tools have attained, through technological advancement, a high level of accuracy that only skilled technicians could realize in the past. Also, through the progress of computer software technology, preparation of drawings for dies and molds has become much easier than in the past. Besides these developments, remote control technology regulating machine tools has advanced substantially recently, so that it becomes possible to transmit the information of mold drawings as digital information, and control operation of machine tools from a

remote place. In other words, if drawings for a product are available, it becomes possible to prepare drawings of dies and molds for the product at one place, and transmit digitized information of these molds to remotely control machine tools and manufacture these dies at another place. Thus, dies and molds at the producible level can be manufactured anywhere in the world as far as technology is concerned.

3. Conclusion

This collection of research papers contains the achievements of studies conducted by the domestic research group in Japan, and the results from the questionnaire survey conducted in Taiwan and Korea. Chapter 1 and Chapter 2 contain part of the achievements of the domestic research group in Japan. Chapter 1 summarizes "characteristics of metal die and mold production technology in Taiwan and Korea." Chapter 2 is a summary of the interim report concerning the results from a questionnaire survey conducted in Japan. Chapter 3 contains the result of a questionnaire survey conducted by Chen Ming-Fong (Director, Global Affairs Office of ITRI),our Taiwanese research partners. Chapter 4 summarizes the result of a questionnaire survey conducted by Dr. Lee Husang (Director, Automation Research Department of KIMM),our Korean research partners.

The results of these questionnaire surveys indicate the fact that business performance of Japanese die and mold manufacturers has been worsening substantially, while to the contrary performance of their Korean and Taiwanese counterparts have been growing. Die and mold manufacturers in Japan, Korea and Taiwan have all suffered a substantial decline of the unit price awarded, and in particular the Japanese makers are experiencing worsening business results primarily due to the declining product prices. Nevertheless, it is revealed that, even in this adverse business environment, the Japanese die and mold manufacturers who have been successfully increasing sales revenues are those who focus on product differentiation, rather than those who seek cost reductions. On the other hand, the Korean and Taiwanese die and mold manufacturers who have been successfully increasing sales revenues are those who have improved their product quality by means of technological innovation, which has resulted into the increase in orders awarded. Specifically, technological innovation in this context represents the evolution of the traditional regime of die and mold manufacturing technology into a process industry.