



24th DAAAM International Symposium on Intelligent Manufacturing and Automation, 2013

## Technology Transfer and World Competitiveness

Soemon Takakuwa <sup>a\*</sup>, Ivica Veza <sup>b</sup>

<sup>a</sup> Nagoya University, Graduate School of Economics and Business Administration, Furo-cho, Chikusa-ku, Nagoya, Aichi, 464-8601, Japan

<sup>b</sup> University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, R. Boskovicica 32, 21000 Split, Croatia

### Abstract

Technology transfer and international competitiveness are closely related. In Japan, many companies that once dominated manufacturing technology have lost their market share to foreign companies. In this study, global manufacturing and technology transfer are first described, introducing Toyota's global manufacturing strategy, the flying geese paradigm and China's Technology Transfer from Opening Domestic Market (TTODM) strategy. Then, some major aspects of a competitive environment in today's economy are described, with comparisons between Japanese companies and foreign companies from the standpoints of economics and technology management.

© 2014 The Authors. Published by Elsevier Ltd. Open access under [CC BY-NC-ND license](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Selection and peer-review under responsibility of DAAAM International Vienna

*Keywords:* management of technology, global manufacturing, technology transfer; competitiveness

### 1. Introduction

Japanese companies invented or were the first to produce commercial products such as the DVD player, the car navigation system, DRAM memory, the lithium-ion battery and the liquid crystal display. After these products were first produced, however, foreign companies soon caught up with the Japanese companies that produced these products and established dominant positions in the associated markets. The evolution of the market share of Japanese companies in these product markets is shown in Fig. 1. This pattern is observed since 1990s, when the bubble economy in Japan collapsed; the recent twenty-year period in Japan is called the two "lost decades."

During this period, Japan's economic position in the world has changed drastically, as demonstrated by the following statistics:

\* Corresponding author. Tel.: +81-52-789-2389; fax: +81-52-789-2389.

E-mail address: [takakuwa@soec.nagoya-u.ac.jp](mailto:takakuwa@soec.nagoya-u.ac.jp)

- (1) GDP per capita: 3<sup>rd</sup> in 2000 to 23<sup>rd</sup> in 2008.
- (2) Japan's share of the global GDP: 14.3% in 1990 to 8.9% in 2008.
- (3) World competitiveness evaluated by IMD: 1<sup>st</sup> in 1990 to 27<sup>th</sup> in 2012 [1].

The reasons why a company that used to dominate in manufacturing technology loses its market share to foreign companies are discussed in the following sections. Many Japanese companies have lost their competitive position as a global hub. Global manufacturing and technology transfer are described in section 2, and then, some major aspects of a competitive environment in the current economy are considered in section 3.

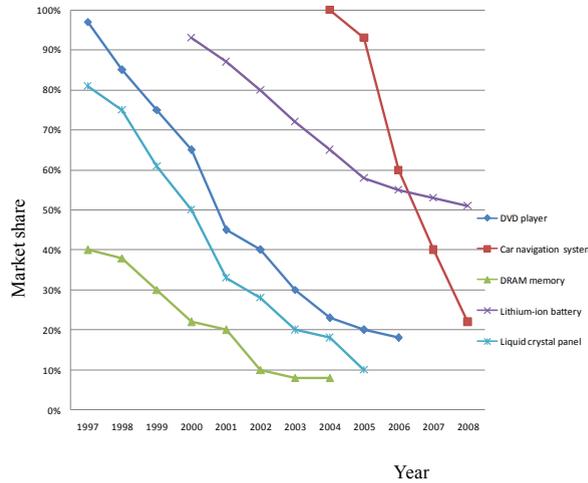


Fig. 1. Global product marketshare for Japan. (Source: [2])

## 2. Global manufacturing and technology transfer

### 2.1. Trade

The evolution of intermediate goods trade among countries and regions in Asia and Asia Pacific is illustrated in Fig. 2. In 1990, Japan dominated the intermediate goods market, whereas in 2010, China took over the dominant position in the market. In addition, Japan's trading partners are shown in Fig. 3. China is the first trading partner for Japan and the U.S.A. which used to be a first trading partner for Japan but is now a second trading partner. Furthermore, South Korea, Taiwan and ASEAN countries are major trading partners for Japan. Today, various supply chains have been constructed across Asia.

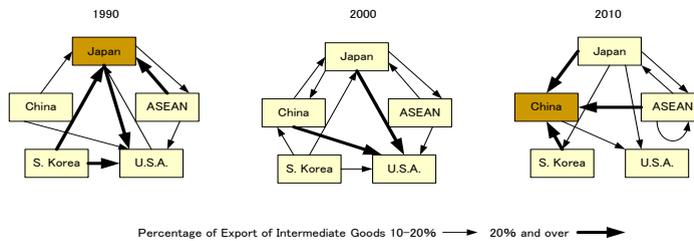


Fig. 2. The percentage of intermediate goods exports. (Source: [3])

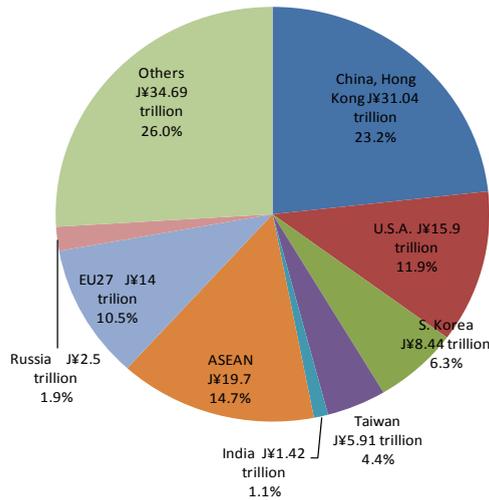


Fig. 3. Trading partners of Japan. (Source: [4])

### 2.2. Global manufacturing

This section discusses the history of global manufacturing. Fig. 4 shows the evolution of global manufacturing, including foreign and domestic production for Toyota Motor Corporation. The subsequent phases are as follows:

- [Phase 1] Single unit pack
- [Phase 2] Knock down (KD) production
- [Phase 3] Production in developed countries
- [Phase 4] Production in BRICs.

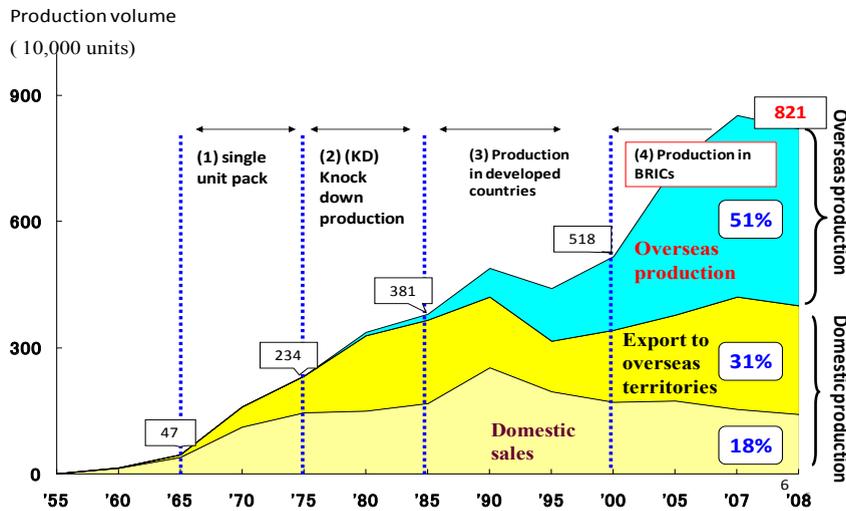


Fig. 4. Global manufacturing of Toyota. (Source: [5])

### 2.3 Flying geese paradigm

Trade is the most important vehicle for transferring new goods and technology across countries. Imports from more advanced countries, i.e., “leaders,” introduce new goods to “follower” countries. Through imports, “follower” countries also receive the technology and capital goods that are needed for the subsequent production of these new goods and, eventually, for their export to other countries. Lastly, when a country loses its competitive position in a particular product market, its domestic production is phased out and replaced by imports from a “follower” that has successfully established a competitive position in that product market. The subsequent phases are as follows [6]:

[Phase 1] A developing country exports particular products to a developed country and imports industrial consumer goods.

[Phase 2] A developing country increases its economy to produce consumer goods that have been imported.

[Phase 3] A developing country exports consumer goods, and begins to produce capital goods and consumer durable goods. In addition, the developing country increases its economy to import primary products, such as materials and provisions

[Phase 4] A developing country exports capital goods and consumer durable goods and, at this point, becomes an advanced industrial nation.

### 2.4 China's TTODM strategy

As an emerging country, China introduced Technology Transfer from Opening Domestic Market (TTODM) in the mid-1980s as a strategy to gain advanced foreign technology and managerial skills through an inflow of Foreign Direct Investment (FDI). China's automobile industry is a model case of this strategy, and China's high-speed train industry is the latest example [7]. The evolution of automobile production in China is shown in Fig. 5. The subsequent phases are as follows:

[Phase 1] Opening the market

[Phase 2] Attracting foreign investment

[Phase 3] Establishing effective competition

[Phase 4] Facilitating technological innovation

[Phase 5] Developing technology

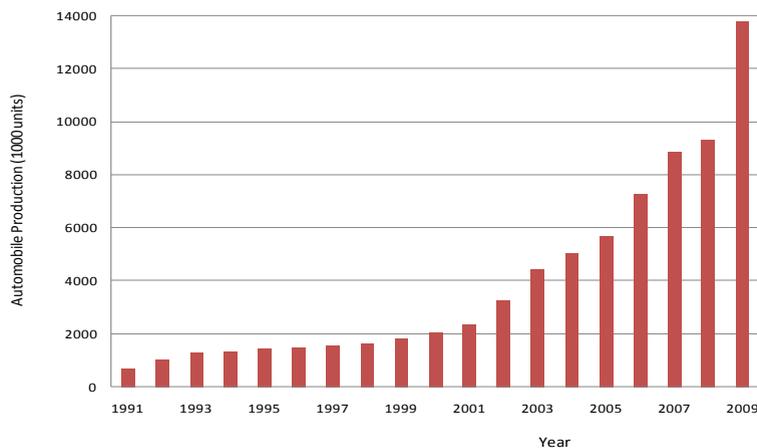


Fig. 5. Automobile production in China. (Source: [8])

### 3. Current aspects on international competitiveness

#### 3.1. Structural change of the world economy

When G7 was established in the mid-1970s, approximately one-half of the global GDP was produced by the seven G7 countries, but the global GDP share of these countries has gradually decreased. Today, G20, which includes several developing countries, accounts for most of the global GDP. Western industrialized nations once dominated the world economy, and Japan's industry was once referenced as "Japan as No.1." Asia, which had been considered the world's factory, became a large market. The middle-income class of emerging countries has been increasing, and these consumers in each country demand products at low prices. In emerging Asian economies, many companies have achieved rapid growth by specializing in low-cost mass production as OEM/ODM for European and U.S. companies. Japanese companies should be encouraged to develop a new manufacturing strategy, by considering various global manufacturing trends [3].

#### 3.2. Product architecture

Product architecture is description of the ways in which functional elements of a product or system are assigned to its constituent sections or subsystems as well as the ways in which these elements interact. In integrated architecture, the physical elements of a product or system share functions. By contrast, in modular architecture, each function is delivered by a separate element. Modular and integrated architecture schemes are illustrated in Fig. 6. Product architecture influences product design and manufacturing methods, including assembly, sales, usage and maintenance. It is easier for a new comer to entry a market as a manufacturer of products with modular architecture. For example, a personal computer is composed of a display, a hard disk, a keyboard, and a CPU. Companies from Asian countries, including China, South Korea and Taiwan, have recently become prominent manufacturers of such components.

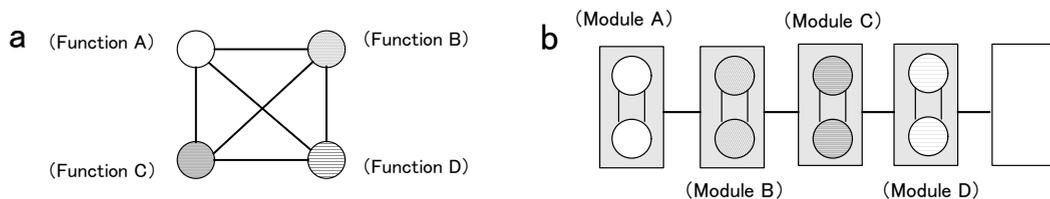


Fig. 6. (a) integrated architecture; (b) modular architecture.

#### 3.3. Information technology

In our advanced society, information technology has influenced not only business and manufacturing but also society and the economy, particularly since the mid-1990s when the internet was introduced to world. Digitization enables data and information to be converted into a digital format that can be easily handled with various types of media, and to be sent around the world instantly. In the manufacturing industry, technologies such as CAD/CAM have increased the effectiveness and efficiency of manufacturing processes. Moreover, the introduction of high-performance production facilities has facilitated the manufacturing of products of a consistent quality in emerging economies [3]. The evolution of the use of software in automobile electronics systems is shown in Fig. 7.

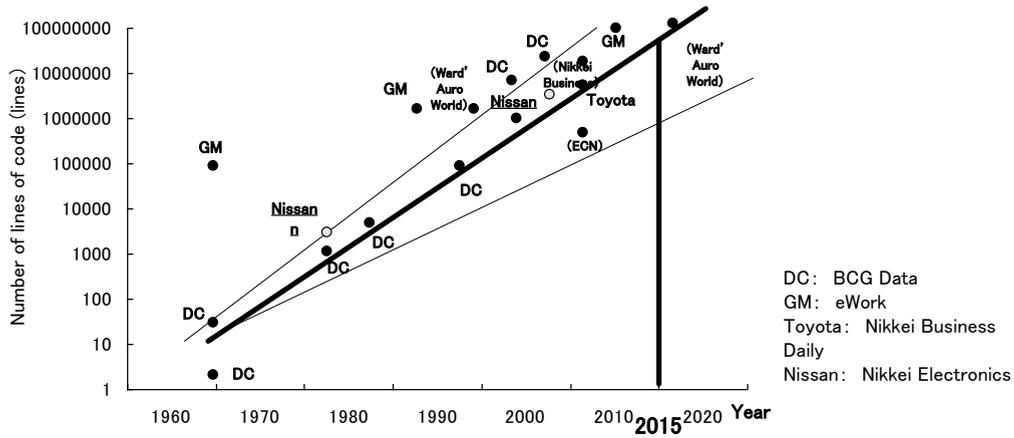


Fig. 7. Evolution of the use of software in automobile electronics systems. (Source: [3])

3.4. Vertical integration and horizontal integration

Vertical and horizontal integration (or specialization) are manufacturing strategies. A company can increase profitability and efficiency through vertical and/or horizontal integration. Traditionally, in Japan, most manufacturers of assembled products tended to adopt vertical integration with domestic parts suppliers to promote self-sufficiency. By contrast, companies in emerging economies have succeeded in producing products at a lower cost with horizontal integration, increasing their global market share. These two strategies can be used together and should be used to suit the occasion.

3.5. R & D and intellectual property

Trends in the efficiency of capital investment (operating profit/R & D expenses) from 2005 to 2010 are shown in Fig. 8. Enterprises in Western countries spend much more on R & D, whereas those in Asian countries spend less. In this context, it is important to establish strategies for managing intellectual property and know-how produced through R & D. Whether to “open” or “close” (i.e. in a black-box) the manufacturing of a developed technology should be determined carefully to dominate the international market of the associated product in the future.

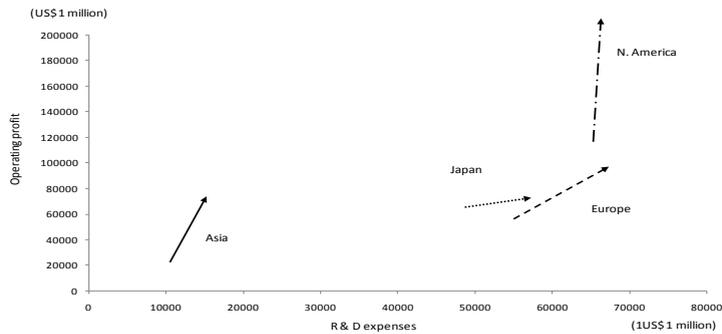


Fig. 8. Trends in the efficiency of capital investment (operating profit/R & D depreciation). (Source: [3])

### 3.6. Human resource in terms of technology leakage

Personnel and engineers within a company achieve innovation through continuous daily activities. Engineers are occasionally acquired from foreign companies. In addition, experienced engineers who played an important role in developing a key technology retired. These engineers may then work at new foreign companies, and the core technologies that they developed may transfer to these companies. Hence, human resource management should be used after engineers retire or leave a company to prevent technology leakage to foreign competitors.

### 3.7. Enterprises in relation to the nation

In Japan, relatively more companies may operate within a specific industry such as the railway, liquid crystal display and water industry, whereas foreign countries such as South Korea may have one or a few companies operating within the same industry. Although the overall market size in South Korea is smaller than that in Japan, South Korean companies generally have a higher domestic market share compared with Japanese companies within the same industry. However, prevailing in the global market differs from doing so in the domestic market.

In addition, the industrial policies of countries such as the U.S.A., Korea and China aggressively target specific strategic fields. Moreover, the corporate tax in Japan is relatively high compared with that in foreign countries. Furthermore, state capitalism has had serious implication for the global economy and competitiveness [9].

## 4. Summary

This study discusses the reasons why the Japanese companies that once dominated the technology market lost their markets share to foreign companies, considering technology transfer and world competitiveness. First, global manufacturing and technology transfer are described, introducing Toyota's global manufacturing strategy, the flying geese paradigm and China's TTODM strategy. Then, some major aspects of a competitive environment in today's economy, including the structural change of the world economy, product architecture, information technology, virtual and horizontal integration, R & D and intellectual property, human resource management and the relation of enterprises to the nation, are discussed. Although these factors may affect each other, they are discussed individually to analyze the reasons why Japanese technology companies lost their market share to foreign companies, especially from the standpoints of international economics and technology management.

## Acknowledgment

This research was supported by the Grant-in-Aid of the Japan Society for the Promotion of Science (JSPS).

## References

- [1] IMD, World Competitiveness Yearbook 2012, IMD International, Lausanne, 2012.
- [2] Ministry of Economy, Trade and Industry, Japan, Status and Problems over Japanese Industry, 2010. <http://www.meti.go.jp/committee/materials2/downloadfiles/g100225a06j.pdf> (in Japanese)
- [3] Ministry of Economy, Trade and Industry, Japan, The White Paper on Manufacturing Industry (Monodzukuri) 2012, 2012. <http://www.meti.go.jp/report/whitepaper/mono/2012/> (in Japanese)
- [4] Ministry of Finance, Japan, Trade Statistics of Japan <http://www.customs.go.jp/toukei/info/>
- [5] S. Takakuwa (ed.), Manufacturing Management in East Asia, Chuo Keizaisha, Tokyo, 2012. (in Japanese)
- [6] K. Akamatsu, A historical pattern of economic growth in developing countries, *Developing Economies*, 1, 1962. 1-23.
- [7] S. Takakuwa (ed.), Management of Manufacturing and Technology in East Asia, Science Publisher, Beijing, 2012. (in Chinese)
- [8] China Bureau of National Statistics, Automobile Production in China, 2010.
- [9] I. Bremmer, *The End of the Free Market*, Portfolio, New York, 2010.