Japanese Technical Linkage in the Age of Small Scale Production of Multi-items and Some Lessons for Korea

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〈要 約〉

2次 世界大戰後 선진국의 경제 성장은 消費主義와 이를 뒷받침하는 Ford식 大量生産에 의한 것이었다. 그러나 오일 쇼크 등 경제 여건의 변화는 知識 집약적 高附加價値 제품의 경쟁적 생산으로의 전환을 가져왔으며, 이를 위해 多品種 少量生産 체제가 不可避해졌고, 日本은 이에 잘 적응한 나라이다.

가장 중요한 것은 企業間, 企業內의 技術 연계(TL)인바, 技術移轉, 品質向上, 市場 확대 등이 TL의 성패에 달렸다고 할 수 있다. 어떤 경우에도 人力啓發은 핵심적인 要素인바, CAD/CAM, CIM의 도입에도 人間關係와 人力養成이 중요하다.

TL을 성공적으로 이룩해 낸 일본의 실례는 산업 경쟁력 제고와 고부가가치 제품 생산으로 도약을 필요로 하는 韓國의 科學技術, 산업 발전에 여러 가지 示唆하는 바가 크리라고 생각한다.

(1) INTRODUCTION

After World War Ⅱ, the high rate of economic growth in DCs was achieved through the worldwide diffusion of consumerism and the Fordist mass production system based on low cost oil and energy intensive materials. However, after the two Oil Crises this type of economic growth reached its limit in DCs, and the information intensive small scale prodution of multi-items has been replacing the mass production ever since. Needless to say, some LDCs, especially Korea, are being involved in this wave.

The point I wish to make is following : whether mass production of small items can be converted into small scale production of multi-items smoothly and successfully depends on the nature of inter-firm and intra-firm TL(technical linkage).

The MIT Commission on Industrial Productivity points out that the success of the American economy in the 20th century was a system of mass production of standard products for a large domestic market, while Japen has been successful in pioneering new forms of workplace organization, and more flexible technologies that efficently satisfy the demand of limited segments of the market.

(2) THE NATURE OF INTER-FIRM TECHNICAL LINKAGE IN JAPAN

Close Linkage across Industrial Sectors

In Japan, acquisition of technology form companies in another sectors was considered as important. This form of linkage was seen as increasing in the

future.

The reason why the acquisition of technology from and the supply of technology to other sectors was afforded prime position of importance was because inter-industrial linkage, based on deepened division of labor, had become increasingly indispensable for the development of high value-added products.

The fact that inter-firm TL plays an important role in the age of small-scale production of multi-items can be found in "the technology fusion index". In 1980s, the age of high economic growth in Japan, technology fusion was confined to the individual spheres of the technology system, for example, "the chemical system", "the metallurgy system", "the mechanical system" and "the electrical/electronic systems". However in the mid-1970s technology fusion rapidly progressed between the spheres of mechanical and electrical / electronic systems (mechatronics). Furthermore, in the 1980s technology fusion occured between precision machinery, electrical/electronic and metallurgy spheres (producing CAD/CAM, industrial robotics and office automation equipment), and it also occured between the spheres of mechanics and electronics(resulting in peripheral materials for electronic equipment). Furthermore, the rapid progress of fusion of technology between the spheres of the chemical, mechanical, and electric/electronic systems(resulting in high molecular materials and electro-ceramics) is still proceeding.

Needless to say, information and telecommunication technology is the pivot of today's TL. This is because electronic technology is able to combine horizontally with many other technologies, thus accelerating innovation.

Supply of Technology to the Customer and the Emerging Customer-Oriented Technology Strategy

The most important objectives concentrate on customer-related perspectives, such as "market development of the companies' own products", "requested from customers".

The market-driven technology strategy is much more important in the age of small scale production of multi-items, and this might lead to the advantage of Japanese firms, who generally rely on the technical tie with customers. For example, over 50 percent of all new product ideas in Japanese steel originated from the customer feedback on product defects or advantages.

TL between Firms and their Suppliers of Parts

Strengthened technical ties with the suppliers of parts, which leads to the improvement in the quality of parts in "zero defect", is indispensable for small lot production, because faulty parts and zero inventories damage the smooth and continuous production.

Generally, the technical tie between the assembler and its suppliers of parts in Japan is the closest among DCs. In Japan, long-term and stable collaboration with suppliers of parts enables the companies to make the pofitable investment in human resources management, and induce smooth exchange of technical information, which could lead to the improvement of quality of parts.

For example, Japanese automobile companies force suppliers of parts to participate even in the early stages of product design in order to develop new types of parts efficiently. As a result, metal molds can be modified or improved in the stage of product design.

Market Type vs. Non Market Type of Technology Transfer

Technology supply to or introduction from companies in the same sector is small. Needless to say, this arises from the fierce competition in the marketplace. Nevertheless, this does not mean that technology aquisition from the competitors in the same sector is not necessary.

A company has two main sources of technology. The first is in-house R&D and the second is the acquisition of innovation generated elsewhere through licensed contract. In-hous R&D is difficult without non-market type of technology transfer, e.g. imitation, reverse engineering, analyzing patents or collecting information from technical papers and so on, because technically no company is able to maintain autarky. Therefore, in-house R&D inevitably is accompanied by non-market type of technology transfer. Thus this type of technology transfer could play a more important role in the constitution of TL, especially TL among companies in the same sector, than market type of transfers.

Some studies show that fifty to sixty percent of innovation in Japan is obtained without market type of technology acquisition.

Generally, it is considered that the non-market type of technology transfer is encouraged by the fierce competition. On the contrary, monopolistic or oligopolistic conditions in the market is often considered to be one factor which may discourage innovation and non-market type of technology transfer.

The Form of Technology Transfer and the Affilliatedness

Technologies are transferred to affiliated companies mainly through face-to-face contact. This fact shows that long-term and stable relations between companies are one of the important factors for smooth technology transfer, as face-to-face contact is the most effective medium for all forms of techology transfer. Face-to-face contact largely includes visits by technical personnel and training, collaborated R&D and exchange of technical information.

Vintage of Technology Supplied and the International Technology Transfer

The fact that the proportion of technologies, supplied within 2 years after innovation, amounts to 50 percent of total supplied technologies shows unexpected swiftness of transfer. The period of time between innovation and technology supply appears to have become shortened.

Technology is supplied to domestic companies at an earlier stage than it is to foreign companies. Technology supplied to LDCs is often older than that of DCs. However the possibility of transfer of new technology to LDCs should not be ignored.

The restrictive factors peculiar to technology supply to LDCs is caused by LDCs' non-existence of valuable technology to exchange with DCs. The inferior technological level of LDCs themselves causes further lowering of technology levels, in other words the accumulative or vicious circle.

(3) THE NATURE OF INTRA-FIRM TECHNICAL LINKAGE IN JAPAN

Functional Integration and Horizontal Intra-Firm TL

Functional integration is the key for companies to survive and prosper. In other words, companies' competitiveness largely depends on the effective functioning of all areas, especially in the age of small scale production of multi-items. First, this is

because the relationship between product design and production engineering, which enables products being designed to be made flexibly and with high productivity, is becoming increasingly important as the basis for efficient manufacturing. Secondly, the necessity for the improvement in quality of parts or products requires the close tie between production engineres and skilled workers on the shopfloor. Thirdly, a close relationship between product design and marketing is required because the core of R&D strategy is gradually changing from the possibility in mass-production to adapting to the customer's personal feeling or to creating market needs.

Generally, it is considered that the relationship between product design, production engineering, production management and marketing is closer in Japan than anywhere else. For instance, in comparison with US companies, more R&D proposals in Japanese companies are derived from the marketing department and customer suggestions.

First, in age of small scale product of multi-items, horizontal TL, which is prevalent in Japan, could enable more efficient functional integration, as opposed to vertical or hierarchical. This is because adaption of the production scheduling and reorganizing production process to market fluctuations or uncertain market needs are achieved through direct and horizontal coordination among production engineers, production management staff, skilled workers and marketing staffs on the shopfloor. On the contrary, vertical TL is likely to prevent firms from flexible response to the frequently changing market needs and rapid technology progress.

The second reason why functional integration is strong in Japan is that the process of reverse engineering needed to assimilate imported technologies in 1950s and 1980s still remains.

Face-to-Face Technology Transfer and the Team Efforts

The close horizontal linkage in Japanese companies has been based on the exchange of technical information through face-to-face contacts, team efforts, simultaneous engineering, high quality in workers and so forth.

Technology cannot be adequately transferred through written language. An established theory is that the implementation of transfer is dependent on human factors, and that face-to-face contact is the most effective medium for all forms of technology transfer. Close personal communication is the key factor for succssful transfer.

The fact that the team concept is attributed more to Japanese companies than their counterparts can be explained by various factors. For example, engineers in Japan are not reluctant to introduce valuable ideas developed by a collegue or an engineer from another companies. On the contraty, engineers in the US or Western Europe are likely to resist the introduction of ideas by someone else, i.e. "Individualism" or "Not-Invented Here Syndrome".

For these reasons, development lead time in Japanese autmobile companies is 43 months as opposed to 82 months in the US.

Human Resources Management and Job Rotation

Information intensive small scale production of multi-items is impossible without the education or retraining of engineers and workers, in other words human resources management. Job

rotation is one of the most effective means.

Compared with only 14 percent of US engineers who were assigned to production, 35 percent of Japanese engineers were assigned to production at some point in their career, and over 25 percent of Japanese employees are trained as engineers, most of whom eventually move from R&D into manufacturing where they usually stay. This percentage of staying has been slowly increasing for a long time.

Looking at another example, 82 percent of Japanese engineers report at least one job rotation assignment, compared with only 35 percent of American engineers, who reported at least one job rotation.

Job rotation is popular in skilled labor, too. Laborers are required to possess many skills for collaboration across traditional departmental boundaries, because they must be assigned to the various work spots, so that the production process can flexibly respond to the frequently changing production schedule.

Another reason for necessity of the education of skilled labor is because "zero defect" in parts must be satisfied for the smooth flow of production in small inventories, which arises from small lot size product. Faulty parts in zero inventories will lead to stoppage of production.

In Japanese companies more than 40 percent of the work force was made up of college-educated engineers, and all had been tranined in the use of CNC machines. In US firms, only 8 percent of the workers were engineers.

CAD/CAM/CAE and the CIM(Computer Integrated Manufacturing) Systems

Information intensive small scale production of multi-items could not be achieved without overcoming the contradiction between productivity and flexibility. This is solved partly by computerization in all areas, e.g. CAD/CAM/CAE and CIM. Furthermore, CIM, on which all sequent activities ranging from commercial activity to product design, production design, manufacturing and shipment of products are networked and integrated, is indispensable. CIM is the goal for all manufactures.

CIM is classified into two types. The first, which US companies tend to use, attaches more importance to the development of software, as opposed to development of skills in using CIM. In this type of CIM, the information on design in the laboratory is located at the center of the total system. The second type of CIM, which Japanese companies tend to use, is distinctly different from the first type. This second type places more importance on the skills of the operator, as opposed to the development of software, and that the approach to the total CIM system begins from FMS.

The software of the CIM system, however, cannot completely substitute for human decision makings and/or know-how of the workers on the shopfloor. This is because without human decision it is impossible to change the order of the actual production activity, and because mechanical troubles or errors of operation are inevitable. All of these problems cannot be solved by the software of CIM system alone, and furthermore subtle techniques of operating robotics are impossible to be programmed. All of these situations render human involvement indispensable.

Therefore, human resources management is becoming much more important paradoxically, as computerization proceeds.

In reality, in the Omron, one of Japanese leading office equipment companies, the

cost of education of operators, i.e. skilled labor on the factory floor, requires 30 percent of the total investment in CIM system.

(4) SOME CONCLUDING REMARKS AND LESSONS FOR KOREA

Japanese TL could be applied to Korea, which is entering the stage of information intensive small scale production of multi-items, even though not only the level of economic development but also cultural or social values are different between both countries.

I would like to outline some lessons for Korea, which can be drawn from Japan's previous experiences.

(a) Today, Korea is faced with difficulties in industrial transformation, which is characterized by the shift from basic material industries to assembly/processing industries, and by the conversion from Fordist mass production to infromation intensive small scale production of multi-items. The smooth process of this transformation largely depends on whether Korea will be able to establish TL suitable for new paradigm.

(b) The development of high value-added products needs close TL across sectors, which is complemtened by the tie with universities and research institutes. Flexibility and productivity cannot coexist without the deepening of inter-firm division of labors within R&D or production.

(c) Market-driven R&D and production system must substitute for mass production and the supply-driven system.

(d) Long-term, stable and friendly relationships among companies enable effective face-to-face technology transfer, which includes OJT, collaborated R&D and technical information exchanges. This can improve quality in parts and products.

(e) In-house R&D , accompanied by non-market type of technology transfer, is indispensable for technology acquisition from companies in the same sector. TL, in which the portion of non-market type of technology transfer is small, cannot be successful. Non-market type of technology transfer is encouraged by fierce and fair competition in the marketplace.

(f) Close functional integration is enabled by horizontal intra-firm TL, which is based on face-to-face technology transfer, team efforts, job rotation, simultaneous engineering and so on.

(g) Automation in all areas, or CIM, is indispensable. However, effective CIM is impossible without human resources management.

(h) Today's fierce technical friction might lead to Korea's difficulty in technology introduction from DCs. But the most decisive factor restricting technology transfer between DCs and LDCs or NIES is not secrecy of technology in TNCs or restrictive business practices, but the low technological level in LDCs or NIES themselves. In other words, one of the most important reasons why TNCs don't supply technologies to LDCs is becaues LDCs or NIES have few technologies attractive to DCs. LDCs or NIES with affluent technologies to supply to DCs will be able to introduce technologies easily, because technological autarky is difficult even in DCs in the age of small scale production of multi-items, and beacuese the specialization and deepened inter-firm division of labor within R&D or production are proceeding rapidly. I think that New International Technology Order is equivalent to close international TL, where the technologies are exchanged on a large scale between DCs and LDCs or NIES, and that close international TL could be attained through establishing domestic inter-firm and intra-firm TL in LDCs or NIES. *