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The Production System of Korean Automobile Industry

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I. Introduction

Korean automobile industry achieved dramatic development from the stage of simple assembly of knocked-down parts to the country of 5th production volume in the world during last 30 years. This development might be achieved by many factors inside or outside of the country compositely, but it might be impossible without the support of production system by which automobiles were produced efficiently.

The production system of world automobile industry experienced revolutional change since 1970's. The Fordism or mass production system, which has been the dominant paradigm of production system contributing mass production and mass consumption during 20th century is confronting a crisis now. It was a very efficient system of producing standard product in large volume. But the mass production system cannot respond to the trend of circumstances in which demand is diverse and market is segmented. The production system suitable for producing standard product in a large volume cannot adjust to changing models or volume flexibly according to the change of demand. The workers also cannot display the ability (or the skill) of changing the contents of work according to the change of product models or volume and experience various side effects coming from the sense of severe alienation at the work.

The new production system which comes after mass production system is focusing on the overcoming these limit of mass production system. How to innovate the production technology enabling to change the product models or volume according to the demand change and how to reorganize the job of workers and work organization enabling to be

suitable for this production technology is rising as the main task. In other words, 'flexible' technology and 'flexible' work organization suitable for the flexible technology are the common requisites for the new production system. In this context 'Lean production system' pulls attention as the alternative production system of the new era.

How the production system of Korean automobile industry has developed in the above context? And what characteristics does it have? The development process of Korean automobile industry during last 30 years in terms of production system has been the process of realizing economy of scale by way of mass production. The Korean automobile industry having started from the stage of assembling knocked-down parts established mass production system in the 1980's. But we hardly can say that Korean automobile industry adheres to the mass production system forever. It began increasing the flexibility of production technology by way of automation in the 1990's. It also tries to increase flexibility in terms of work organization.

How can we define the production system of Korean automobile industry at this point? Has it transferred to the flexible production system or does it still stay at the mass production system?

The purpose of this paper is to review the development process of the production system of Korean automobile industry and to identify major characteristics of it. This paper will focus on the following question especially.

What are the characteristics of the production technology, the work organization, and the production management system comprising the production system by each development phase? More specifically speaking, it consists of following three questions.

1) What are the characteristics of production technology? How does each machine consists of and how has the automation been made? How is the control of each machine made?

2) What are the characteristics of the work organization according to the production technology? How are the workers organized and what job does each worker do?

3) How does the production management system exhibit efficiency linking the production technology and the work organization?

II. The production system, the Mass production system and the Lean production system.

(1) The production system

In this paper production system means the method of organizing technical and human factors at the production site. It is a synthetical concept which comprises 3 concepts, the production technology by which final product is produced, the work organization which is the form the job of workers are accomplished, and the production management system which links these two factors. So the production system is not technological concept solely. It is the composite concept of technology and human beings who use technology. When new production system emerges, there comes not only technology innovation but also the innovation of work organization and production management system. It is impossible to change production system without changing human factors.

(2) The Mass production system

When we confine the discussion only on the dimension of production system, the Fordism means the mass production system which maximized the efficiency of production by way of extreme division of labor, that is conception and execution of work.

The production technology of Fordism consists of special purpose machinery suitable for producing standardized product in a large volume and the conveyor belt which enables flow production by linking the machines.

The workers accomplish extremely fractionized jobs repeatedly completely excluded from the conception of work. These works are done through the organization made by the principle of Taylorism which means the standardization of the work and the scientific management.

The production management system of Fordism is the mixture of technical control system and bureaucratic control system. It means that it controls production by the technical control system and bureaucratic control system side by side. In the technical control system the work depends on the movement of conveyor belt without self-control of workers. In the bureaucratic control system the position and the salary is differentiated by the promotion ladder.

But the Fordism could not respond to the trend of circumstances in which demand is diverse and market is segmented. The production system suitable for producing standard product in a large volume could not adjust to changing models or volume flexibly according to the change of demand. The workers also could not display the ability (or the skill)

of changing the contents of work according to the change of product models or volume and experienced various side effects coming from the sense of severe alienation at the work.

(3) The Lean production system

The new production system which came after mass production system is focusing on the overcoming those limit of mass production system. How to innovate the production technology enabling to change the product models or volume according to the demand change and how to reorganize the job of workers and work organization enabling to be suitable for this production technology is rising as the main task. In other words, 'flexible' technology and 'flexible' work organization suitable for the flexible technology are the common requisites of new production system. In this context 'Lean production system' pulls attention as the alternative production system of the new era.

The production technology of the Lean production system is characterized by the multi-purpose machinery which can produce diverse models of product by changing the computer program put in the machines and the information control system which transmit the production plan to the machines and coordinates the production by getting the data on the state of production. It also works with JIT(just in time) delivery system which delivers various components and parts of vehicle to the assembly line just in time of production.

The workers of the Lean production system are in charge of not only the execution but also a part of conception of work. They use wide range of knowledge on the overall production process and they are trained multi-skilled in order to do various jobs by way of job rotation and job enlargement. Most of the works are done by the workers team.

The production management system motivates the workers to participate in the production process voluntarily. QC circle and the suggestion system are representative management tools of the Lean production system.

III. The brief history of Korean automobile industry and the classification of phase in terms of production system.

In Korea modernized automobile manufacturing didn't begin until Saenara Motor Company constructed its assembly plant in Bupyoung in 1962. There had been only handicraft rebuilding of military trucks or jeeps into buses or trucks before Saenara. Saenara began to assemble sedan style cars using semi-knocked-down parts imported from Nissan

at the final assembly line. Saenara stopped assembling cars after 1 year or so of operation and Shinjin Motors took Saenara's Bupyoung plant. HMC(Hyundai Motor Company) and Asia Motors constructed their car assembly plant respectively late in the 1960's. They all assembled cars with knocked-down parts. Not only the ratio of localization was low but also most local parts suppliers were small sized because the car assemblers imported most of their components or parts from abroad and produced cars in a small volume.

Kia Motors set about manufacturing local engines and sub-compact cars when it constructed its Sohari plant in 1973. This plant was the first integrated automobile manufacturing facilities equipped with conveyor system in Korea. It was integrated facilities composed of several unit plants such as engine manufacturing plant, stamping plant, body-assembly plant, painting plant, and final-assembly plant whereas former Korean automobile manufacturing facilities were composed of only final-assembly plant. Korean automobile industry came to stand on its modernized production base as GMK(GM Korea) constructed its engine manufacturing plant in 1974 and HMC constructed an integrated automobile manufacturing facilities in 1975. This stream was induced by the Long-Range Automobile Industry Promotion Plan promulgated by the Korean government in 1974. Local parts suppliers came to secure steady demand on their product as the production volume of automobile assemblers increased and localization ratio of automobile improved.

In the beginning of 1980's, Korean auto manufacturers set about mass production driving export-initiated growth strategy. In 1981, HMC pushed ahead with a project to design and produce a sub-compact car embodying world frontier technology and aimed at export market with the production capacity of 300 thousand cars a year. HMC developed a new sub-compact model Excel. Daewoo and Kia also adopted export-initiated growth strategy. Daewoo pushed ahead with a project to manufacture the sub-compact model Lemans, which was German Opel model originally, with the collaboration of GM and aimed at export market with the production capacity of 167 thousand cars a year in 1984. Kia pushed ahead with a project to manufacture the sub-compact model Pride, which was Japanese Mazda model originally, with the collaboration of Ford and aimed at export market with the production capacity of 120 thousand cars a year in 1985. Korean automobile manufacturers began mass production of automobiles based on growing domestic demand and export demand.

In the beginning of 1990's, Korean auto manufacturers wanted to expand their production capacity. But they didn't wanted to concentrate their plants in one place adding new facilities at existing plant sites. They constructed their new facilities away from their original location. For example, HMC constructed new plant in Asan away from Ulsan, Kia in Asan away from Sohari, and Daewoo in Kunsan away from Bupyoung. Constructing new automobile manufacturing facilities, Korean auto manufacturers made big turns in terms of their production strategy. They began to adopt flexibility strategy to enhance flexibility of production. As the world leading automobile manufacturers adopted the Lean production system, they could not delay adopting it any more. The strategy of Korean auto manufacturers was to progress flexible automation which can accomodate product model or production volume according to the demand change.

HMC set about flexible automation constructing its Asan plant in 1994. Kia and Daewoo also pushed flexible automation constructing their Asan plant and Kunsan plant respectively.

Taking into consideration of the characteristics of production system we overviewed, this paper classifies the development phase of Korean automobile production system into following 4 phases.

- (1) The phase of knocked-down parts assembly(1962-1973)
- (2) The phase of establishing flow process production(1974-1980)
- (3) The phase of mass production(1981-1990)
- (4) The phase of flexible production(1991-1996)

IV. The Characteristics of production system at each phase.

- (1) The phase of knocked-down parts assembly(1962-1973)

At this phase Korean automobile manufacturers began manufacturing automobiles by way of assembling knocked-down parts imported from the overseas collaborators of them.

The production technology of this phase did not have any native base but was completely imported from the overseas collaborators of automobile manufacturers. So we can see only the characteristics of production facilities and assembly technology of the overseas collaborators having no relations with local condition.

For example, HMC imported most of core components and parts needed to assemble Cortina including engine and transmission from Great Britain as a form of knocked-down kit. In terms of manufacturing process core processes such as stamping, casting, forging, machining for

engine parts were executed in Great Britain and HMC executed only body-assembly, painting, and final-assembly. All the production facilities of HMC at this time were imported from Ford and the production system itself was based on the Fordism, or the mass production system. But the productivity was about 15 vehicles per day(1969). It shows that the production efficiency of this phase is very low even if they imported mass production facilities from abroad.

The workers of this phase at assembly plant engaged in the simple labor work which didn't require any high level skill. The production management was not executed systematically based on simple control using face-to-face relations.

(2) The phase of establishing flow process production(1974-1980)

At this phase HMC adopted the strategy of designing and manufacturing their own model and increasing localization. In order to introduce their own model, they had to do engineering of their manufacturing process by themselves. Korean automobile manufacturers began to obtain, digest and absorb foreign production technology on a full scale by way of technology licensing and R&D of their own from this phase. In order to manufacture the new model Pony, HMC constructed an integrated automobile facilities based on the line assembly concept. The other two Korean car manufacturers, Kia and GMK also constructed their new plants based on the line assembly concept.

At this phase Korean auto manufacturers realized continuous flow process of manufacturing cars linking all the manufacturing processes in a line. With this type of production, all the processes from the initial body assembly to the final assembly are linked by the conveyor belt and production is executed continuously without interruption. So it is also called flow production. HMC constructed its new plant with the concept of flow production with the production capacity of 56 thousand cars per year on December, 1975. These facilities had following processes such as engine-manufacturing, stamping, body-assembly, painting, and trimming and final-assembly.

As the flow production was realized, scientific management method where standardized works were organized began to be applied. Workers became to execute fractionized works repeatedly dependent on the conveyor speed. But simple control rather than technical control was more prosperous by this time.

Although the Korean automobile industry at this phase realized flow

production manufacturing, the economy of scale by mass production was not realized because the production volumes of each auto manufacturers were around 50 thousand cars per year. We have to admit that the mass production system was not established fully by this time taking into consideration that full economy of scale is realized when the production capacity of a manufacturer reaches to at least 400 thousand cars a year.

(3) The phase of mass production(1981-1990)

In the beginning of 1980's, Korean auto manufacturers set about mass production driving export-initiated growth strategy. In 1981, HMC pushed ahead with a project to design and produce a sub-compact car embodying world frontier technology and aimed at export market with the production capacity of 300 thousand cars a year. Daewoo and Kia also adopted export-initiated growth strategy. Daewoo pushed ahead with a project to manufacture the sub-compact model Lemans, which was German Opel model originally, with the collaboration of GM and aimed at export market with the production capacity of 167 thousand cars a year in 1984. Kia pushed ahead with a project to manufacture the sub-compact model Pride, which was Japanese Mazda model originally, with the collaboration of Ford and aimed at export market with the production capacity of 120 thousand cars a year in 1985. Daewoo's and Kia's strategy has similarity with that of Hundai in the point of driving mass production of cars aiming at export market.

Toward this end, Korean auto manufacturers began their effort to enhance their technology capability by way of licensing and R&D. As the new car models were developed aiming at the export market, it was inevitable for them to keep with the world frontier production technology. HMC adopted a policy of obtaining technology for styling, prototype car manufacturing, productivity and quality control from several sources rather than single sources on the other hand Daewoo and Kia adopted a policy of obtaining technology for car design and manufacturing from single sources of their collaboration.

a. Automation and mass production

In order to identify the characteristics of production system at this phase we need to observe the machines operated at the manufacturing facilities. Most of them were special purpose machines suitable for manufacturing standardized product in a large volume. The proportion of special purpose machinery of Korean Big 3 during 1982-1986 period

increased more than two times compared to before(1975-1981) and the proportion of automation also increased 1.7 times. In case of Kia's Sohari plant constructed in 1987, most of machines for the transmission machining process were typical special purpose NC(numerical control) machines. The industrial robots were also installed mainly at the facilities for the strategic cars for export. Total number of industrial robots installed at the Korean automobile manufacturing plants in 1987 was 488 units and it was 39.1% of all the industrial robots installed in the country. The number of industrial robots in 1998 was 606 units and 86.5% of them were installed at the body-assembly plant and 4.0% of them were installed at the painting plant. Most of these industrial robots were play-back robots doing simple repetitive jobs and had the characteristics of special purpose.

b. Work organization and production management

The characteristics of work at the car assembly plant at this phase was typical Fordistic work process. Most of the workers executed their jobs in accordance with the flow of conveyor belt resulting from the characteristics of car manufacturing, that is all the processes were linked in a line. In case of final-assembly line, 2 to 3 workers per process worked on the work-in-process or parts riding the conveyor belt about 6 meters long. The characteristics of the jobs done dependent on the flow of conveyor belt were inevitably completely simple, repetitive, standardized work which anyone can master without difficulty.

The work at the car assembly plant was organized based on the Taylor's scientific management principles. The workers repeated the work upon the work direction made under the scientific management principle in as short as possible time. Workers only repeated standardized simple works whereas the management possessed overall conception of works and related knowledge. The work control was technical control as the ordering and monitoring of the work was done by the machine.

At this phase, QC circle and suggestion system was introduced to enhance productivity by way of increasing sense of belonging and participation of workers. But they don't seem to fix their place because the condition of work environment at this phase did not mature enough.

(4) The phase of flexible production(1991-1996)

In the beginning of 1990's, Korean auto manufacturers began to adopt flexibility strategy to enhance flexibility of production. As the world leading automobile manufacturers adopted the Lean production

system, they could not delay adopting it any more. The strategy of Korean auto manufacturers was to progress flexible automation which can accommodate product model or production volume according to the demand change.

HMC set about flexible automation constructing its Asan plant in 1994 after it tried FBL(Flexible Body Line) system at the body assembly line of existing plant in the beginning of 1990's. Kia and Daewoo also pushed flexible automation constructing their Asan plant and Kunsan plant respectively.

Korean auto manufacturers developed flexible automation technology mostly with overseas facility suppliers jointly. For example, HMC developed its FBL system of Ulsan #2 plant jointly with Yamashita Co. in Japan, which had the experience of supplying FBL system to Toyota. The core facilities of HMC's FBL system were imported from Japan and the other facilities were developed by HMC. HMC made overall master plan of automation at its Asan plant with the consulting of Japanese Kantou Auto Co. and German IPK. The facilities and the software were purchased from the domestic and overseas companies such as LG-EDS and Fujits.

a. Flexible automation

At the flexible automation line of Korean auto manufacturers various models can be manufactured with slight change of system design and facilities such as jigs and the volume of each model can be changed easily. This kind of multi-models production is possible with the support of information system.

Now let's identify the characteristics of production technology at HMC's Asan plant which is considered to go farthest to the flexible automation among Korean auto manufacturing plants.

First, it increased automation compared to Ulsan plant, installing AS/RS(automated storage and retrieval system), dimension inspection machine, automated sealer applying machine, etc.

Second, it made the most use of ergonomics for the workers to work in comfortable environment with ease. It decouples long final assembly line into 12 assembly zone with the buffer zone between each assembly zone. It also uses multi-torquing machine and flexible-height working table.

Third, it doesn't allow the active participation of workers in spite of above comfortable working environment. The workers are excluded from autonomous decision on the production because information system

operates production facilities collecting the data on the status of production.

b. Work organization and production management

How does the work organization change corresponding to the flexible automation in Korean automobile industry? It is noted that flexible automation require different ability and quality of workers from prior special purpose line. Workers of flexible automation process should do not only process control, computer programming, and machine repair as their main job but also quality control, cleaning, and maintenance as their side job. Companies should have systems and training programs for their employees to acquire those ability.

But Korean auto manufacturers expanded their flexible automation against this trend. In other words, Korean auto manufacturers expanded automation excluding the participation of workers supposing that they are not capable of responding to the change of production autonomously.

HMC adopts job rotation only on limited area. HMC has not executed the restructuring plan including overall rotation against the veto of union although it prepared that plan in 1994.

V. Conclusion

Korean automobile industry achieved dramatic development from the stage of simple assembly of knocked-down parts to the country of 5th production volume in the world during last 30 years. The production volume of 1996 is 2,811,181 units whereas that of 1962 when the assembly of knocked-down parts began was 1,777 units, showing the increase of more than 1,500 times for 34 years. This paper aimed at identifying the characteristics of the production system which contributed to the dramatic growth of Korean automobile industry.

We could identify the development process of Korean automobile industry as being in pursuit of the strategy of mass production. To this end Korean auto manufacturers developed and manufactured cars for the export market. So we could identify the characteristics of Korean automobile production system before 1990's as a typical mass production system. But their strategy is changing to the Lean production system since 1990's.

The present situation of Korean automobile industry is characterized by the combination of flexible automation technology and Tayloristic

work organization. In terms of production technology, flexible automation by which multi-model production is capable is far developed. But in terms of work organization, basically Tayloristic work organization is maintaining in which simple, repetitive job is executed although autonomous job rotation is done partly.

Under the flexible production system, the further flexible automation is progressed, the more flexible work organization is needed. Korean automobile production system could be said as the incomplete flexible production system in the sense that production technology is not so flexible as to respond sensitively to the change of market demand and that work organization has still Tayloristic characteristics.