The Holons Settlement of the Processing and Assembly System for the Human-Oriented Manufacturing System Forming.

(인간중심의 제조시스템 구축을 위한 가공 및 조립시스템의 Holon 설정)

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Abstract

The manufacturing system has been changed from labored manual process system, which is managed and operated by managers and operators, to CIMS(Computer Integrated Manufacturing System) for integration of manufacturing, research, development and consumption in the age of diverse customer's needs[6]. However, because it involves the hierarchical system composed of many sub-systems interface and its installation & setup cost is very expensive, CIMS has many difficulties in constructing the durable optimal system that is able to adapt to rapid in-outer circumstance change. So, HMS(Holonic Manufacturing System), the new conceptual manufacturing system having the self-problem-solving and self-organization[11], is instructed to solve these difficulties that it has in these days. The system flexibility in the HMS is able to be ensured, with the integration of human's strong points into mechatronics manufacturing system to reduce interference among sub-systems.

In this paper, the manufacturing process rationalization and integration of the assembly line in an automobile industry, has lots of problems in efficiency and productivity, has been studied in an early stage of converting the present state of process system to HMS, which is human-oriented processing system, to improve the line efficiency, system productivity and reliability by using human capability effectively. This paper is derived into the human-oriented & object-oriented holons settlement of the shop floor system composed of processing, assembly and material handling system for the future holonic manufacturing system, which is going to be computer supported control system.

1. The Objectives of the Study

This study considers the manufacturing system and control process composed of the frame processing, assembly and rack storage of the automobile seat manufacturing line. The analysis of each process and line layout is conducted, and then, the material flow analysis in parts processing, this have the objective that is the efficiency, productivity and flexibility improvement of manufacturing process through the settlement of holons, in which human and processing characteristics are flexibly harmonious.

The study on the processing system of each line is directed to human-process system and human-human interactions[13], time and motion factors that have effect on the work and organization system.

The study on the material handling system among process is directed to the material flow from the former process to the latter process, storage and transportation of the parts in process. Otherwise, shop floor space and time factor(layout and production capability) having effect on the line balancing among sub-processes.

2. The Status Analysis of the Manufacturing Process and Control System

2.1. The process and control system in the frame processing shop

The organization of the frame process has three separate sub-organizations controlled by a manager, front-seat line, rear-back and rear-cushion, which are composed of a few sub-processes. The front line is established with a bending machine, a press machine, a spot welding machine and three

welding robots, each of which is controlled by a labor. The rear-back line with three welding robots and a manual welding machine. The rear-cushion with two welding robots, a manual welding machine and a sub-assembly processing.

Through the analysis of all the working time and the delicate time, it is revealed that the ratio of idle working loss, caused by ineffective manual material handling, is more than the other factors.

2.2. The work and control system in assembly process

The assembly process is consisted of two sub-assembly lines, each of which have several sub-work stations, highly depending on the labor's condition, labored manual working method. The stagnation of assembly process and labor's idle state brings about because of line-balancing discordance among the trim station and sub-assembly station, this makes the ratio of delicate time is much low as compared with the working time, the productivity is less than the production capability.

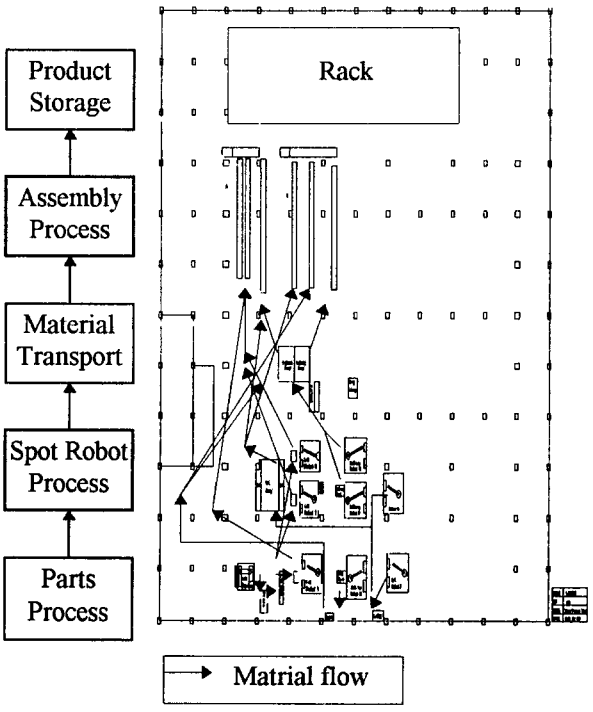
2.3. The production control and material handling between frame and assembly process

The manufacturing line has many problems, inadequate quantities of in-process inventory and unbalancing between frame process and assembly process. The material transport paths are reverse, bent and intersect with one another in the shop floor, as shown at Fig. 1.

As the method of transport between frame and assembly is dependent on the material transport team, which is influenced by human factors. So, the former process produces and supplies more quantities of sub-assemblies than the latter process needs so that the shortage of the products is prevented. The management and control of this material handling system has difficulty in keeping and preserving the materials exactly.

3. The Control System Analysis of Processing, Assembly and Material Handling on Human Factors

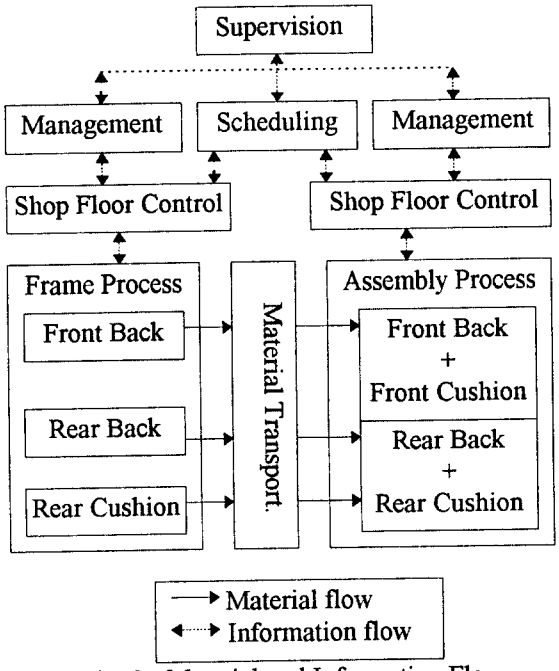
To analyze the manufacturing system and identify control and management system that manager and worker want, the manufacturing process and information flow are grasped. The manufacturing control and management system are implemented by two important functions, scheduling and control, which generate the datum of manufacturing function and working status information. This data and information involve



<Fig. 1> Shop Floor Lay-out

the input, process, output datum and information in the company with worker's information at shop floor[15]. These are feedback into the production scheduling and shop floor control and management function as quantified datum and information, however, the qualitative information about workers, who play important roles for manufacturing process, production output, are not importantly considered, caused by the structural problems about hierarchical control and management system. To implement agile manufacturing, the information is instantly traveled and holds in common[9]. This is achieved with distributed information system on which the authority of the manufacturing control system must be endowed with worker's ability. The management and control of this manufacturing system are performed with method of not endowing individual with the authority but centralized decision making. So, this system can not be rapidly adapt themselves to the changed manufacturing environment and cooperation industry, and then, this system must be changed to the distributed system that effectively handles the change, formed as the authority and self-regulation are endowed with workers at shop floor. Under the new environment, the high-value added information must be produced and the standardization of working and information

treatment is achieved[9]. The change of the manufacturing system in the company with that of the information must needs the reform of manufacturing control process[9]. However, because the quantity of order is often changed unexpectedly by the market changes, the equalization and the motivation of production are insufficient. As these essential requirements are not sufficient, this manufacturing system has the waste of human resources, the time delay to achieve the its objective in wanted time.

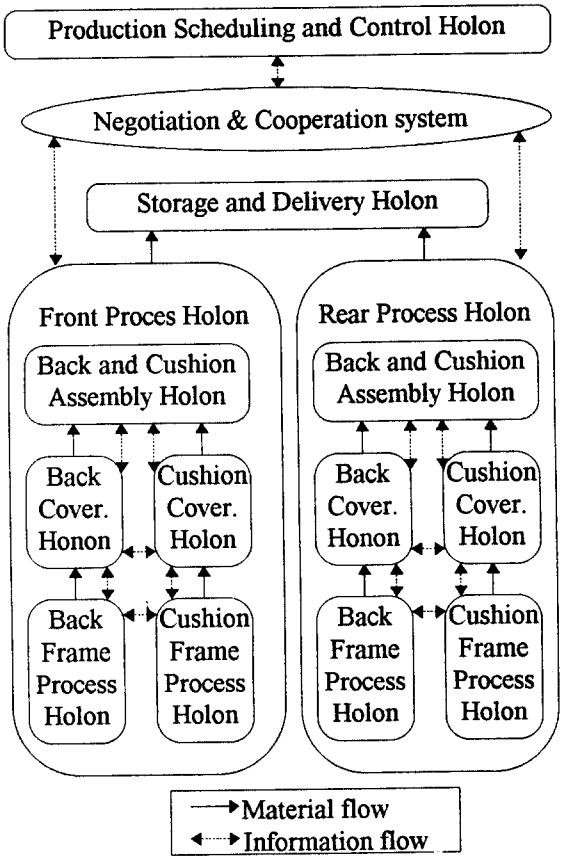


<Fig. 2> Material and Information Flow

Before the holonic manufacturing system is set-up, the process of that is identified definitely[9], as shown at Fig. 2. It is changed to the system that can over come unexpected environment and changes. Human is effectively matched to the system, and then, the system has the flexibility of the process. That is needed to set-up time and material transportation time is minimized[8].

4. The Holons Settlement of the Shop Floor Process and Control System

The human-oriented holons settlement of the shop floor control system is for the effectiveness of the process, the rationalization of the materials flow between the former process and the latter process, making the information flow rapid and become in common. The authority of the scheduling and control, which endowed with the supervision and management, is reduced, and then, the reduced parts of that must be transfer into the chiefs of holons at shop floor. The holon is the unit component that produces the parts, sub-assemblies and products independently. The holons are able to treat the manufacturing system information by themselves and in conjunction with the other holons[11]. A holon, which able to specific project that performs system process reforming is organized and the mediation system composed of holons is formed to link the ability and function of each holon effectively. The cellular manufacturing system that have the characteristics of the holon, made-up with the optimum members, is engaged to the changed system, it devoted to the reduce of adjusting time to the changeable schedule, the achievement of the minimum working space and materials in process. In the cell, the optimum quantity of the materials in process is set in consideration of the work space[13] and cycle time by the simulation S/W, ProModel. The complexity and loss, caused by the time, distance and frequency of the transportation, is reduced and the paths are optimized by the process analysis.



<Fig. 3> Holonic Manufacturing System

The number of the workers in a cell is able to changed according to the change of the quantity of the orders. The idle worker in a cell is reassigned

to the other cell through the mediation of the conjunction group[11] among cells in a holon or the other holon. The line balancing between the former cell and the latter cell is achieved through the basic work and time study[7] and the process simulation, that essentially is the basis on the conjunction of holons.

Because the interaction between frame process and the assembly process is cut-off, the frame process can not be adjusted to the assembly process and have the cognition about its step in the current status of the whole manufacturing process. Especially, the ability of the assembly process can not cope with that of the frame process, so, the materials on the interface of these two processes is many and here are the sub-work team plays the role of transportation.

To improve the production ability, the assembly process, which is consisted of two sub-lines having the three straight lines, is changed into the two holon with four sub-holons that produce four major sub-products. These changes devoted to reduce the worker's idle time according to the bottle-lack of the line caused by unbalanced and ineffective assembly process. Through the division and association of the work units, the cells are reformed, and then the process analysis is for the holons settlement. The four holons are the front back assembly holon, front cushion, rear back and rear cushion. These four holons are matched to the frame process. Like as the assembly holons, the frame process have the four holons processing the parts supplied to the matched assembly holon. In the viewpoint of the whole, each of the major three holons, front back holon in frame and assembly, front cushion, rear back, and rear cushion, is adjacent in the layout. Also, each adjacent holon have closely relationship, cooperation and adjustment in discrete scheduling and control of the production process, as shown at Fig. 3. The manufacturing information is owned jointly. The three major holons have the mediation group[11] that has the authority of the solving the problem of the process jointly, sub-scheduling and control according to the production scheduling. The major holons are directly matched to the performance of the order and production information flows to forward and reward direction on the close human interactions and computer supported information system. This holonic system pursues the simplification of the system by eliminating the complexity of the material handling and information processing. A holon is subordinated to the higher holon, cooperated with the companion holon, independent on the lower holon[11]. The cell in the holon is set with the elimination of idle motion by working motion improvement and simplification and working method improvement by the convenience of working motion[7]. The work is allocated to human or machine by the analysis of work characteristics, simple, complex and diverse. This approach pursues the harmony between human and automation[11].

5. Conclusion

A lot of interfaces among components in the management and control of the manufacturing system disturb the simplification of the manufacturing and information process. As the hierarchy system is changed to holonic system, consisted of human-oriented holons, integrating human resources into the manufacturing system effectively and worker's motivation is achieved. The reforming of the holon is attained as the result of the process analysis and the establishment of the optimum cell used the simulation.

The process control analysis needs the system development that is able to analyze the system exactly, efficiently. The analysis factors, manufacturing process, information process, human relations, organization and so on, must be systematically defined. Especially, the interaction and relationship between human and information system must be deeply studied, and then, the integration of the human resource in the holonic manufacturing system can productively be realized.

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