Production Information Monitoring System for CIM in Footwear Industry

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***Abstract*—**This paper presents a production information monitoring system as an infrastructure of CIM system in footwear industry. The system is composed of hardware devices of terminal, communication converter, line controller and software for manufacturing processes. A terminal like a scanner is used for shop floor data input and a line controller is used to link between terminal and server. LAN and RS485 are used for connecting hardware components and deliver their information mutually. In the system, real time production information is acquired from information resources such as group of uppers and soles. The collected production information is delivered to a line controller and analyzed. Server receives information from line controller and machines for production management. Production planning information that is machined in the server is delivered to the shop floor and used for the production management of work in process, and used for improvement of productivity in a footwear production company. The implementation of the developed system shows the effectiveness of the system.

Index Terms—CIM, Production Information Monitoring, Shop Floor Control, Footwear Industry.

I. INTRODUCTION

A footwear product is composed of a number of various components according to its function, size, color etc. The components can be classified into two groups which are upper group and sole group. They are manufactured, transferred and assembled in manufacturing and assembly departments, and a footwear product is produced. If one of these components is not manufactured or one manufactured is not found in the assembly department, a footwear product planned cannot be assembled into a finished product. These footwear manufacturing circumstances of disharmony in an assembly set place, various components and variety of production volume in each size make production management difficult. So in order to overcome such a difficult manufacturing circumstances, recognition of production volume in manufacturing departments, immediate decision making of a supervisor at shop floor and quick response for change of external circumstances are necessary, and it is required to develop production and process management techniques or systems which satisfy dynamical manufacturing circumstances[1]. In order to control such a dynamic environment efficiently, shop floor information should be collected and delivered in real time, and bottleneck factors of productivity improvement such as indefinite and inaccurate production information and unclear management in process should be resolved.

Computer Integrated Manufacturing(CIM) system offers a number of useful and potential opportunities for improving the performance of footwear manufacturing organizations. The motivation for CIM in footwear manufacturing industry has been based on the need to respond to more rapid changes than the past. Many CIM systems have been studied on manufacturing and management information technology. However, some developed systems have not been based on shop floor data and not applied to industrial field. In order to implement CIM system in a shop floor, real-time information of shop floor should be collected, analyzed, delivered and used to other departments effectively[2,3].

A Point Of Production(POP) system or a Manufacturing Execution System(MES) has been recognized and introduced as a part of CIM system and an effective tool for the efficient shop floor control in many factories. Kim and Han[4] developed POP based integration management system for automobile part

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enterprise. The system supports productive information from mechanical equipment, worker and product by using POP terminal and processes data update automatically. Lee et al.[5] developed a real-time process monitoring system for ship valve manufacturing company. The system is composed of four stages of planning, analysis, design and implementation, and hardware of the system can be constructed at low cost. Another Lee et al.[6] developed a statistical process control(SPC) system as a module of POP system for automobile parts manufacturing firm. The system uses POP terminal with five serial ports in order to input shop floor data and achieves goals of production control and SPC concurrently. Song et al.[7] developed a POP system with open architecture that can support realization of CIM and information network of manufacturing system.

As we can see from the developed system, if a POP system is composed of appropriate hardware devices and software that provides the capability to collect, process and deliver information at the shop floor, the system can be innovated into a POP system or a MES which resolve primarily difficult task for the shop floor control[8-10].

This paper introduces a system that implements functions of real-time data acquisition and management. The system is composed of hardware devices of terminal, converter, line controller and software programs. The system is used as an effective tool that collects shop floor data, delivers to a server and manages shop floor information for shoes production management. The system is called as a production information monitoring system for footwear manufacturing processes.

II. INFORMATION FLOW FOR FOOTWEAR PRODUCTION

A pair of footwear is produced by implementing many functions from receipt of order information to delivery of a finished product.

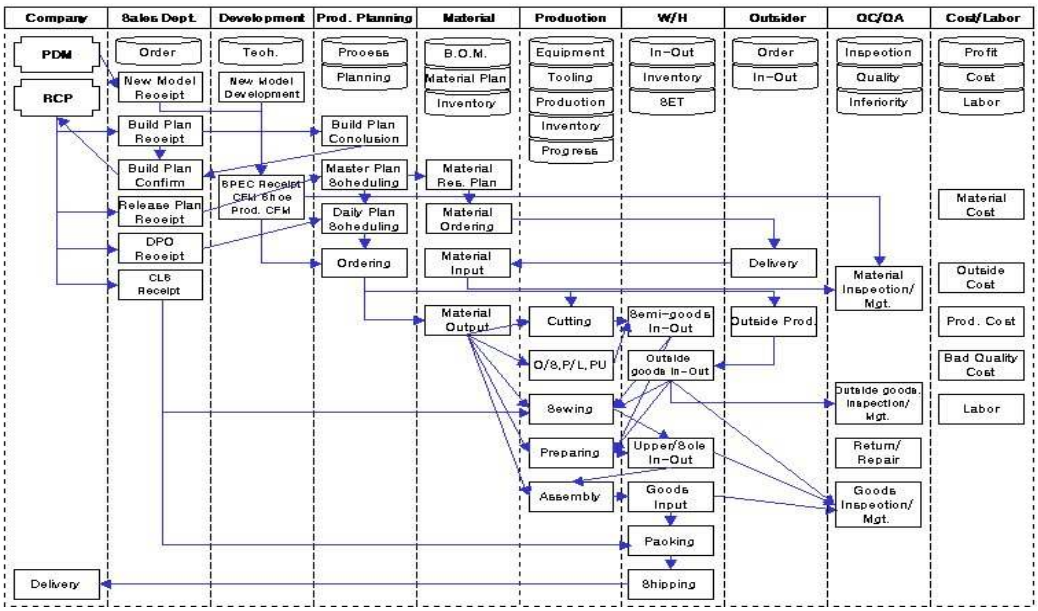

Fig. 1 Information Flow of Footwear Production System

The information flow of footwear production system(FPS) is shown in Fig. 1. In view of manufacturing and management information technology, The software of the footwear production system are composed of 5 modules which are order process(OP), process planning(PP), manufacturing process(MP), material resource planning(MRP) and cost processing (CP). In Fig. 1, the system starts from receipt of order information of a new model. A new model is designed at the development department and a production planning is set up. In production planning department, a master production plan is scheduled, and a material resource planning is established according to production planning information, and materials are ordered and put into a warehouse. According to the operation sheet information,

materials for footwear products are taken out of a warehouse, delivered and manufactured in manufacturing departments for uppers and soles. An upper is composed of many pieces and manufactured by cutting and stitching. Outsole, midsole and insole are made by outsole press, injection phylon press and polyurethane, and assembled with an upper at an assembly set place. A product assembled is tested through quality control department and the finished footwear product is delivered.

The developed system is related to software of manufacturing process module and hardware for shop floor data input in production information flow.

III. MANUFACTURING PROCESS MODULE IN FPS

In order to manufacture a pair of shoes in a shop floor, material is given to two manufacturing areas which are upper and bottom(sole) parts. Cutting and stitching processes are implemented in the upper part, and soles are manufactured and stocked from outsole (O/S) press, polyurethane(PU) and phylon(P/L) press in the sole part. Components of these two parts are firstly collected in two set places which are upper set place(USP) and bottom set place(BSP), and secondly assembled in an assembly set place(ASP) and sent to a footwear warehouse. Fig. 2 shows a process flow for footwear manufacture.

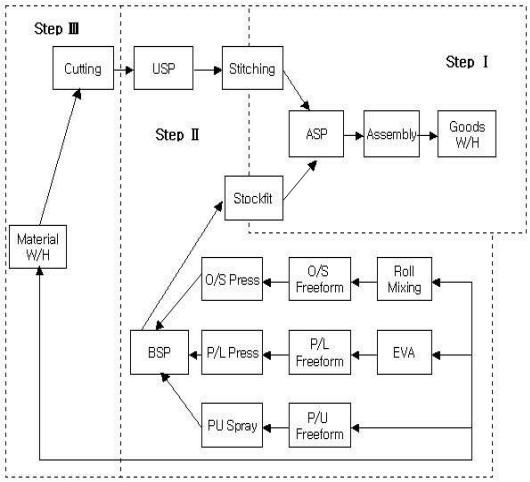

Fig. 2 A Process flow for footwear manufacture

An MP module for FPS plays a role of POP system and uses hardware devices for data gathering, conversion, offering and instruction, and its software are composed of three sub-modules which implements planning, gathering and management.

A. Hardware of MP module

A hardware configuration for the MP module is shown in Fig. 3. The hardware is an effective tool for the efficient shop floor control in many factories and is composed of FPS terminal as a scanner, display board and converter. Their structures are like Fig. 4.

In Fig. 3, a LAN network is structured for the communication with the upper system, and a RS485 network is set up and used for the communication with the lower strata. MS-SQL is installed in the FPS server. A line controller is a personal computer which controls FPS terminals and delivers upper production planning information to the shop floor. It analyzes and saves data which are collected from FPS terminals.

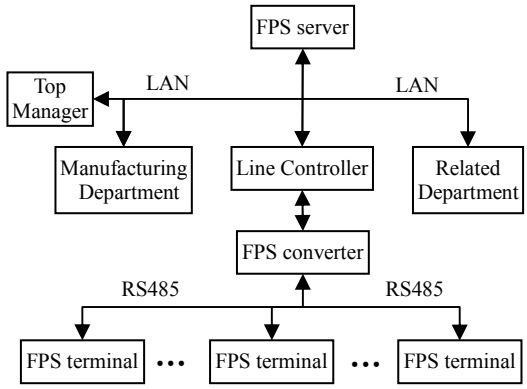

Fig. 3 Hardware layout of MP module

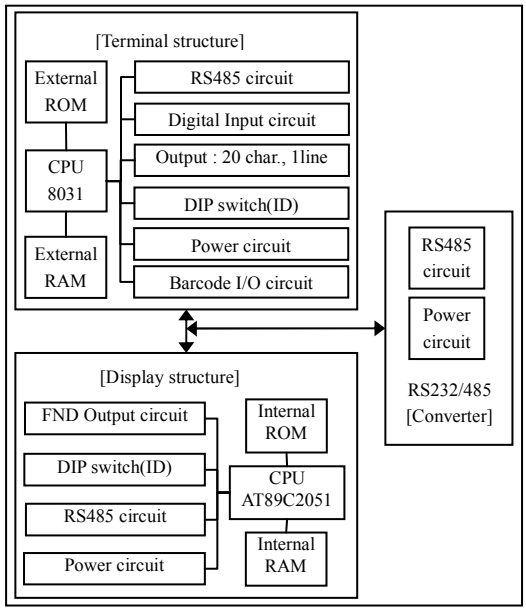

Fig. 4 Structures of terminal, display and converter

A FPS terminal directly collects data through a scanner in shop floor. The unit accepts barcode type

data through a scanner from resources of data, sends the data to a line controller through RS485 network, receives and displays an operation instruction from a line controller. A monitoring board displays the actual production results to a manufacturing department in real time, and field workers can see their actual job progress and efficiency. A FPS converter is a RS232/485 converter which connects between RS485 network and a line controller. The converter plays a role that converts the collected data by RS485 network to the data fitted to RS232C of a line controller. Scanners gather production information from shoes resources at a shop floor.

B. Software of MP module

Information flow of manufacturing processes is like Fig. 5. In production plan department, a process plan is established, information of daily work sheet is input and labels for shoes are printed according to the input information and handed to manufacturing departments in shop floor. Then components of shoes are manufactured according to the output information of production plan and packed by groups, and labels are attached to the packages for management. The attached labels are respectively scanned in manufacturing departments. Scanned data are input and transferred, a line controller collects and saves delivered data in a manufacturing department, and transferred to the main server. The received data are stored at the server, machined and delivered to some necessary departments.

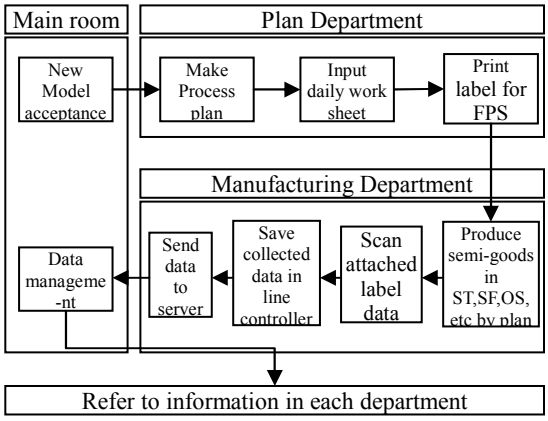

Fig. 5 Information flow of MP module

The software of MP module is composed of three sub-modules. The first is a sub-module which implements planning, production and inventory management by using a special label system, the second implements gathering of shop floor data and communication, and the third is used for system manager. In the first sub-module, operations that implement data change, data control, planning and warehouse management are programmed. Program for real-time monitoring and line control are executed in the second sub-module. Real-time monitoring program is for communication with all manufacturing department and line control program is for assembly department, preparing or sewing department, department of assembly set place, uploading to oracle server and information control of products warehouse. Stock management and configuration program are implemented in the third sub-module. Procedures for data gathering by use of barcode label and initializing main program are implemented in this sub-module. The contents of these sub-modules are summarized in Table 1.

Table 1 Contents of MP module

Contents	Explanation
Data change program	Conversion from specific data to POP data
Data control program	Calculation for inventory, production, input and output status from basic data
Planning program	Key entry program for process plan Program for barcode labeling Sorting program for PO which shipping is completed Key entry program for input of volume of B, C grade in process Modification program for rearrangement of production quantity
Goods warehouse program	Key entry program for goods in warehouse by hand
Real-time monitoring program	Real-time monitoring program for communication of all manufacturing status
Line control program	Program for assembly department Program for preparing or sewing department Program for department of assembly set place Program for uploading to oracle server Program for information control of products warehouse
Tail stock program	Program for data gathering by use of barcode label
Configuration program	Program for initialization of main program

IV. IMPLEMENTATION

The developed production information monitoring program provides users real-time production information, input and output information of warehouse and controls present status of production and inventory. The program was applied to a footwear manufacturing company. Fig. 6 shows a main view in the program that represents real time monitoring.

Fig. 7 is a view of assembly department that shows assembly of uppers and soles. Target

quantity, production result quantity and rate of these two quantities are presented line by line. Actual daily production status of style number, quantity produced in each time, size run for gender are shown in Fig. 7.

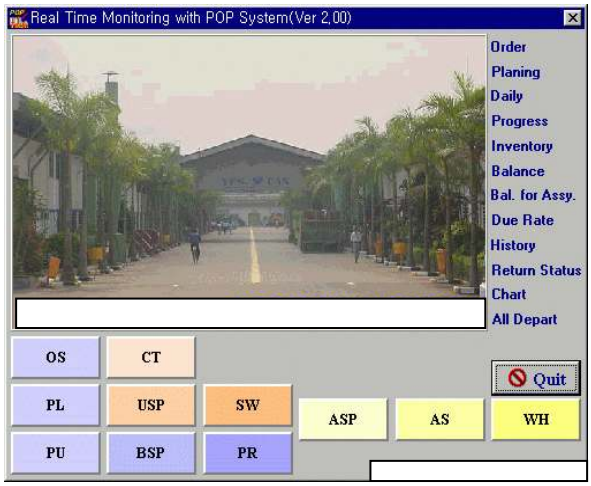

Fig. 6 Main view for real-time monitoring system

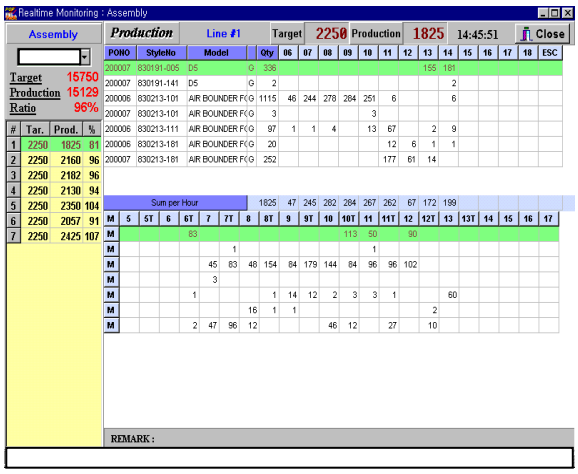

Fig. 7 Real-time monitoring of assembly department

Fig. 8 shows a balance sheet for assembly in planning department. The components produced in each department are counted line by line, and total quantity and quantity of return or reject in each department are counted. These data are used for balancing shoes production plan.

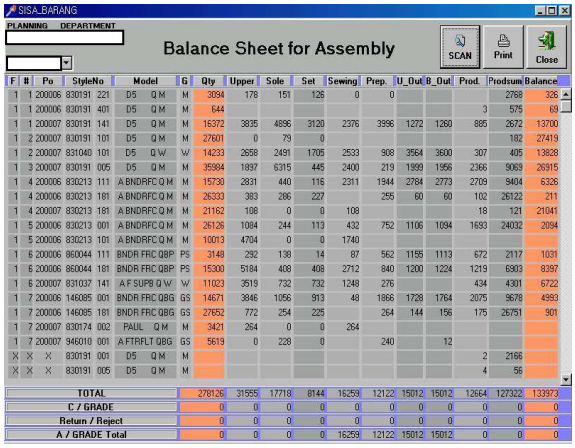

Fig. 8 Balance sheet for assembly

Fig. 9 is a view that shows daily production order and total production order according to the goal date and communicates with every department in order to know present production status that is shown in bright color. Production or non-production volume in a department can be found by analyzing the information of this view. An instruction to produce the lack of volume is delivered to a manufacturing department. This shows a result of production information monitoring system.

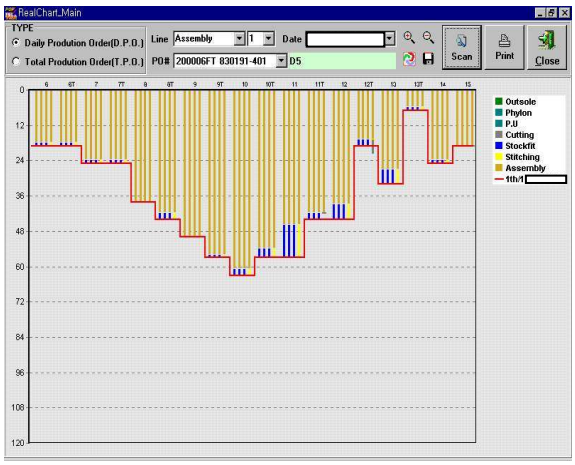

Fig. 9 A view of production status in assembly department

As an application result of the system, the program implementation provided results of 38% decrease of inventory cost in work in process, reduction of lead time, 45% reduction of overrun and inferior goods, definite management of lack of components, time saving in data input and upgrade of operating capacity of field workers.

V. CONCLUSIONS

A production information monitoring system was developed for footwear manufacture. The system is composed of hardware devices and software for production monitoring, and plays information tracing role for real-time information acquisition and production management in shop floor.

The system was applied to a footwear manufacturing company as one module of the footwear production system. As results of application, cut-down of inventory cost in work in process, reduction of lead time, reduction of overrun and inferior goods, definite management of lack of components, time saving in data input and upgrade of operation capacity of field workers were given, and especially the system was very useful to inventory management.

The system that was developed as an infrastructure for CIM system is a practical system that monitors and manages production information in a footwear manufacturing company. But in order to implement CIM system based on shop floor data in a footwear industry, the other functional modules such as material resource planning and cost processing should be developed.

REFERENCES

[1] A. Gunasekaran, S. Y. Nof, "Integration and adaptability issues," *International Journal of Computer Integrated Manufacturing*, Vol. 10, No. 1, pp.1-3, 1997.

[2] K. H. Choi, S. H. Lee, "Hybrid Shop Floor Control System for Computer Integrated Manufacturing(CIM)," *KSME International Journal*, Vol. 15, No. 5, pp.544-554, 2001.

[3] Yamaguchi, *Introduction to a POP system for CIM system*, Ohmsha, Ltd., 1992.

[4] G. J. Kim, J. S. Han, "POP based Integration management System for Vehicle Parts Production Enhancement," *J of the Korean Academic Industrial Society*, Vol. 9, No. 5, pp.1265-1270, 2008.

[5] J. H. Lee, S. H. Lee, and H. O. Oh, "Development of a Process Monitoring System for Real-Time Process Control," *J of the Society of Korea Industrial and Systems Engineering,* Vol. 31, No. 1, pp. 92-100, 2008.

[6] J. C. Lee, J. M. Kim, and O. W. Kim, "Development SPC System of an Automobile Parts Manufacturing Firm under POP System Environment," *J of the Korea Industrial Information System Society*, Vol. 4, No. 3, pp.8-14, 1999.

[7] J. Y. Song, D. H. Kim, and S. K. Cha, "Real-time Manufacturing Control and Information Management System," *IE Interfaces*, Vol. 7, No. 3, pp. 69-76, 1994.

[8] S. H. Yamaguchi, "POP system – High-level Shop Floor Management and its effectiveness," *System/control/information*, Vol. 35, No. 5, pp. 288-296. 1991.

[9] S. K. Cha, H. K. Kim, and J. Y. Song, "Implementation of POP using Client/Server Computing Environments," *Proc. of the 1st ISICIMS*, ERC-ACI., 1994.

[10] J. W. Park, C. H. Lee, "A Study on Construction of POP System with Reliable Acquisition of Production Data," *J of Korea Safety Management and Science*, Vol. 8, No. 6, pp. 79-90, 2006.

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