Advanced Materials Research *Online: 2012-02-27*
ISSN: 1662-8985, Vols. 468-471, pp 2661-2667
doi:10.4028/www.scientific.net/AMR.468-471.2661

Research on Workshop Management System of Body-In-White Pressing Production

Ya-Zhou Chen[1, a], Lin Wang[2, b]
[1] School of Mechanical Engineering, Jimei University, Xiamen, 230009, PR China
[2] School of Computer Engineering, Jimei University, Xiamen, 230009, PR China
[a]yazhouchen@jmu.edu.cn, [b]wanglin626@jmu.edu.cn

Keywords: Body-In-White; Pressing production; Workshop management system.

Abstract. Based on the analyzing of the characteristics of a Body-In-White pressing production process a pressing workshop production management system has been given in order to make the ERP production scheduling more executable. The detailed function model of it such as task assignment, quality control, mold maintenance and production scheduling has been thoroughly discussed. In order to make the production line capability balance the task dispatching algorithm has been given and the dynamic dispatching and controlling process has been explained. This system can be integrated with the upper ERP/CAPP/PDM system which can improve the information level of a company.

Introduction

BIW (Body-in-White) is pointed to the parts that is not yet entered the painting and the interior parts of the body prior to assembly[1]. During to the complexity of the BIW it production on-site management is difficult which mainly because of[2]: white body structure composition is complex which is generally composed of dozens of large and frame parts and hundreds of small components; BIW pressing procedure complexity, for example, a parts pressing generally need to go through blanking, drawing forming, punching trimming, flanging and bending such 3-5 processing operations, and if you pressing hundreds of parts the total procedures may reach to several thousands; the manufacturing resources are wide range and various, according to statistics an annual output of 150,000 body manufacturer contains 20 sets of 2000T (tons) presses devices, 110 sets of fixed and hanging spot welding machine, 20 sets of CO2 welding machine, 199 sets of punching dies and fixture tooling, 11 sets of coating glue equipment, 6 sets of binder machine and etc[3].

Although many companies have implemented ERP/PDM system but as the pressing production procedure and punching device is various in different company so to develop a pressing workshop production management system is needed in order to integrated with the upper ERP /PDM system [4,5,6,7].

The characteristics of pressing process

In order to develop a pressing workshop production management system the characteristics of pressing procedure must be analyzed firstly[8].

The pressing procedure is pointed to the process that a sheet metal is to be cut off or to be formed on the pressure machine which using some punching dies. White body pressing has the following characteristics[1]: ①The pressing parts can be generally divided into the outer cover panel, inner cover (skeleton pieces) panel, small and medium sized panel and simply bending part. Relative to the inner cover panel the outer cover panel structure is simple and the molding process is simple also but the appearance quality of it is demanding, the inner cover panel structure is complex and the molding process is complex, small and medium sized panel and simple curved panel molding process is relatively simple. ②The main procedure of outer cover panel and inner cover panel includes:blanking, drawing forming, punching trimming, flanging and bending; small and medium sized panel pressing procedure includes:blanking,cutting, punching and forming; simple blending parts pressing

procedure includes:blanking, cutting incision,shear,punching bending forming. ③Pressing production is accomplished by a punching die that loaded on a press equipment (single-action press equipment or double action press equipment) which usually adopt a assembly line production methods. The workpiece is automatic loaded or manual loaded and is conveyed manually or with a robot. ④Each parts need to go through 3-5 forming procedure on the assembly line using different forming mold. When the current procedure arising problems the following up procedure must be discontinued, so how to control and coordinate the whole production line is complicated. ⑤ In a feeding period each pressing line produce various panels which belong to different type of automobile according to the schedule which determined by the ERP system. Turns achieved by replacing the mold or die but the total production is a batch production mode. ⑥ When the tonnage, travel or the table installation location of the press equipment is suitable, pressing parts can be shifted from one production line to another production line in order to balance the equipment load. ⑦ A off-line sampling testing approach is introduced in order to control the product quality. Due to the characteristics of the sheet metal forming the quality defects may caused by the current procedure die and may also caused by the previous procedure die. For example when two times drawing die is used the second drawing defects may caused by the first drawing die and may also caused by the second drawing die, so when the defects phenomenon is arising the on-site management operators must analyze the defects reason and take a suitable management measures. ⑧ When the quality defects is arising the workshop production schedule must be adjusted and these information must be reported to the ERP system. ⑨ As the pressing molds is expensive so how to maximum the utilization of these molds in order to achieve maximum return of the investment capital as fast as possible must be considered.

The function structure of this system

The purpose of developing a pressing workshop production management system is to access and transform the real-time resource status to ERP/PDM/CAPP system which can make the workshop scheme and control more practically in order to avoid managing the workshop just by experience[8,9,10]. The framework of this system is shown in Fig.1. The product scheme information is obtained from ERP to pressing workshop production management system in order to steering workshop operation and the on-site information is feeding back to ERP system in order to adjust the scheme, the product structure data is obtained from PDM system to the workshop production management system and the dynamic product process is feeding back to PDM system and the part manufacturing procedure information is obtained from CAPP system to the workshop production management system and the procedure planning variation information is feeding back, so these systems are integrated together and sharing the information may be possible[2].

The main function modules of this system are:

1) Pressing equipment management module. Based on ontological theory these equipments that related to pressing produce such as punching machine, punching mold and check apparatus and fixture instruments and transporting dolly and manipulator are modeled which using uniform interface describing file in order to access the device static information such as type, specification and journey and otherwise and dynamic information such as manufacturing task, device status and operator and device behaviour and otherwise.

2) Panel management module. Auto body is formed from panel on the mold and the panel element is high-powered alloy which is always expensive. Managing the panel is the key factor to control workshop manufacturing cost so the panel dynamic information that passed from one working process to another process is acquired in order to improve the panel utilization ratio.

3) Manpower resource management module. The workshop workers have been divided in administers class, operators class and maintainers class and the worker actual information such as capability, on guard or not and fall ill or not has been collected in order to effectively assign and dispatch produce task.

4) Document resource management module which used to manage part process document, mold maintain sheet and dispatch sheet and arts and crafts sheet and otherwise.

5) Equipment maintain module which used to record the equipment maintenance history. Hold the device history using status can aid to effectively dispatch manufacturing resource and can help to solve a device failure.

6) Task simulation module. When the incident like urgent part produce is added or quality defect is arising or an equipment failure is appeared the workshop task needed to allot and re-dispatch according to the produce scene data.

7) Data collection and gather module. When any resource status is changed these information must be collected through automatic device or input in workshop resource management system manually.

8) Statistic and efficiency analyzed module. Single query mode and multiform query mode are provided in order to achieve the device or the worker or the manufacturing process data at any moment.

9) System management module which used to realized the function of user management, data input and autorotation management and log management and otherwise.

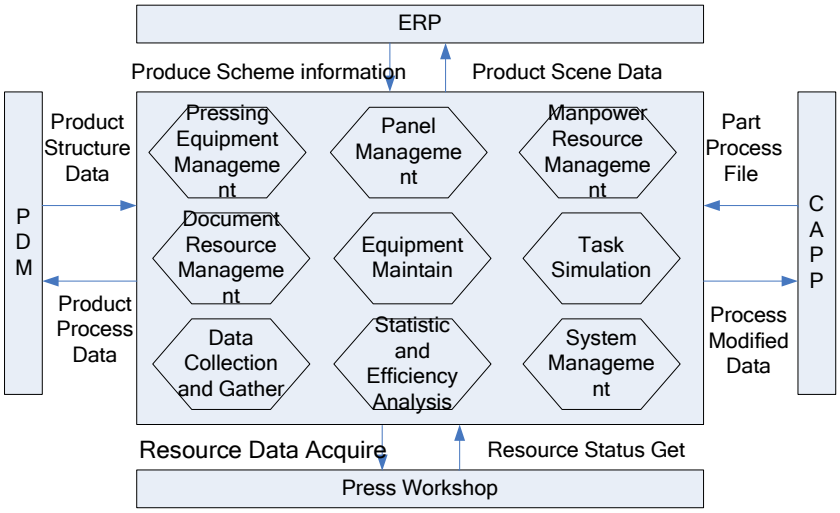

Fig. 1: The Framework of Pressing Workshop Production Management System.

The data model of this system

The main purpose of developing a pressing production workshop management system is to management the press equipment, punching mold, sheet metal, operator, check apparatus, fixture instruments and production task information, so a data model has been given in Fig.2. The product structure data is extracted from the *PDM* system. From the product data we can see the relationship between these parts and each part detailed information can be searched from the part data through part *ID*. The part data include part *ID*, part name, part dimension, part type and etc. In the procedure data each part pressing procedure information has been given such as procedure *ID*, procedure name, procedure type, the part that associated with this procedure, the press that used in this procedure, and the gauge that used in this procedure. In the mold data the mold detailed information can be searched such as the part that this mold used to machine, the status of this mold that whether the mold is in work or is in repairing, the mold that used to manufacturing which type of auto. The scheme task data include the part associated with this task, the tasks planned begin time, and the task planned end time. All these data are organized by a tree structure which can be easily searched, inserted, updated. The detailed information of this data model is showed in Fig.2.

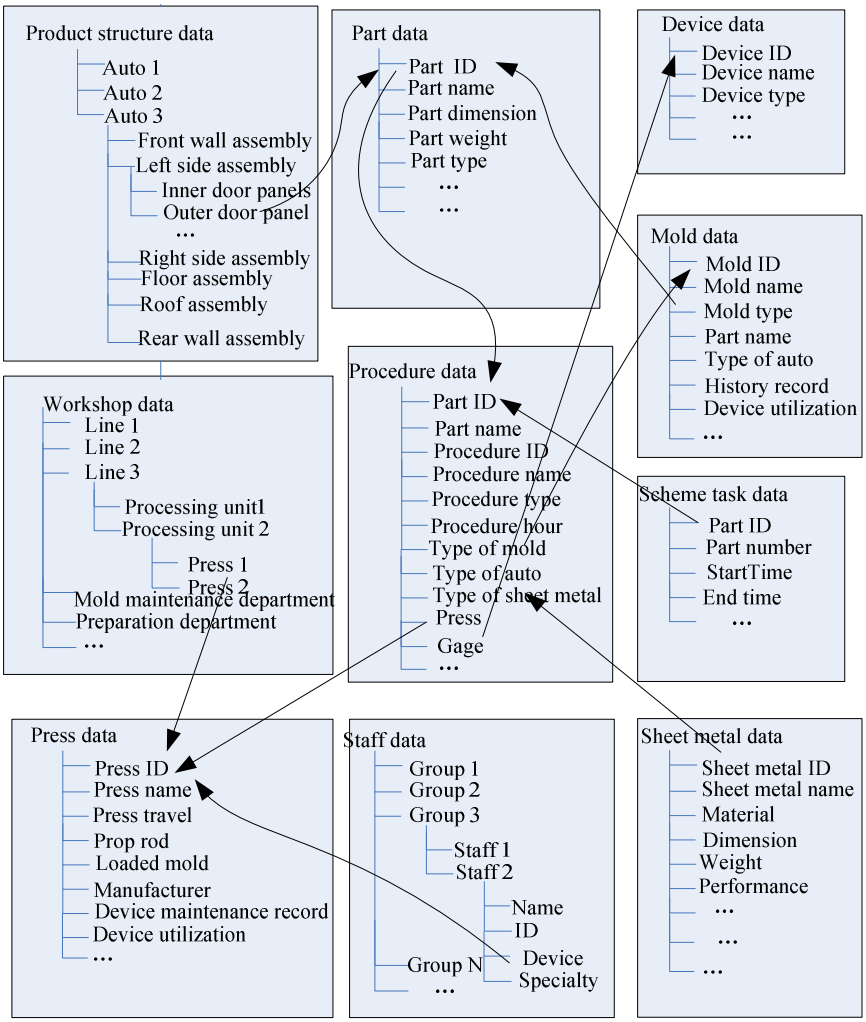

Fig.2 The Data Structural Model of the Body-In-White Press Production

The implementation process of this system

The implementation process of this system has been given in Fig.3 to Fig.7. The production planning information which come from *ERP* system and the process planning information which come from *CAPP* system will be transformed into the punching simulation module of this system. The pressing simulation module using these information and other information such as press equipment, mold status, sheet metal data, operating workers information and processing task data to conduct a simulation in order to get a theoretical manufacturing time which according to the principle that the workshop device manufacturing capacity is limited. Put the theoretical manufacturing time into the production task dispatch module to make a work station task dispatch. Assumed that n types of parts is prepared to punching on a press, according to the principle that the average passed time is as shortest as possible and the largest delivery delays is as smaller as better the detailed simulation process has been given in Fig.3: ① input P_i（$i=1,2,\cdots n$）which is the theoretical manufacturing time and D_i which is the programmed delivery time; ② sort P_i from small to large according to the value of the programmed delivery time; ③ calculate each parts manufacturing finished time F_i by the upper sorted result ; ④ calculate the maximum delivery delay time $T_{\max}=MAX(0,F_i-D_i)$;⑤ calculate the average finished time $F=\dfrac{\sum_{i=1}^{n}F_i}{n}$;⑥ calculate the maximum delay time of each part according to $D_i^T=D_i+T_{\max}$; ⑦ if the part delay time which part ID is k satisfied with

$D_k^T \geq \sum_{i=1}^{n} P_i$,then put this part(P_k)to the end; ⑧ repeat the above process except for the part which part *ID* is *k* and the final production task sorted queue can be attained through one-by-one comparison.

A sample of two production line in a workshop task dispatch simulation has been listed in Fig.5(a) . If a quality defect arising or a equipment failure appearing then a production re-scheduling is needed in order to make a production task re-dispatch which showed in Fig.4 (Step (12)to step (16)), the detailed process will be explained in the following paragraph.

When a quality defect of a punching workpiece is arising the dispatching process is(Fig.6): ① try to find the reason of the quality defect; ② When the part surface have scratches phenomena ea then the reason of the quality defect maybe the feeding device have debris; ③ When the reason of the quality defect is the pressure is not enough so the press must to be repaired; ④When the phenomena are wrinkle, crack,nap and so on then the reason of the quality defect may caused by the mold failure and the mold is needed to be repaired.

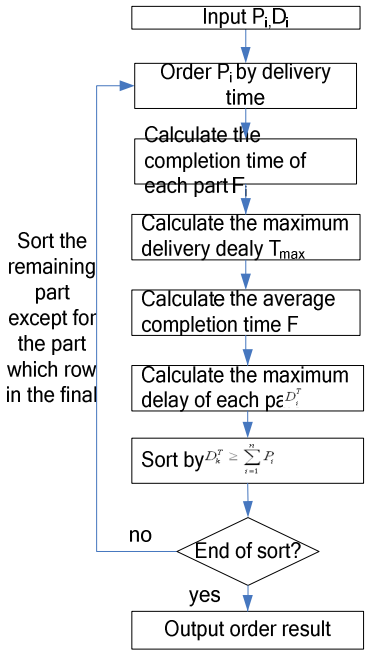

Fig.3 Production Task Dispatching Simulation

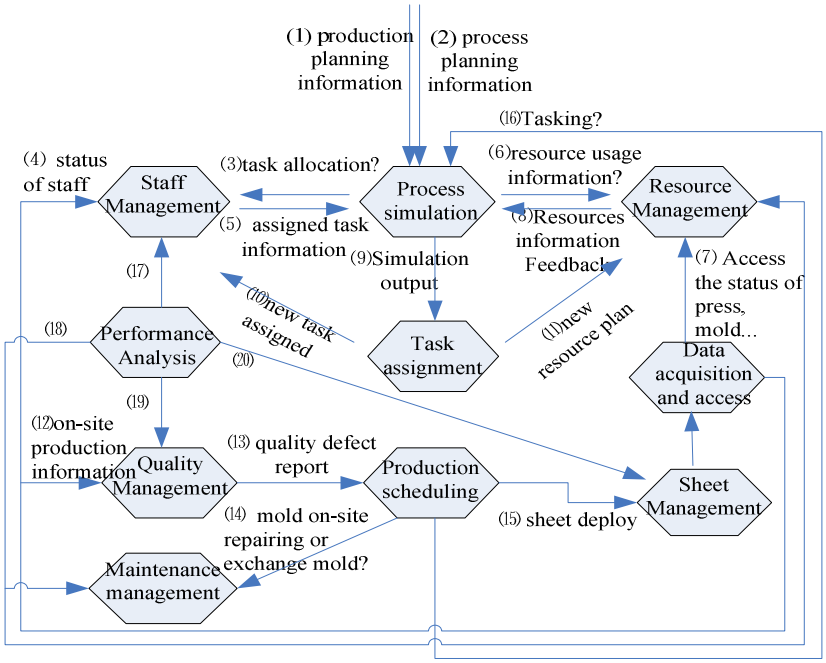

Fig.4 The Execution Process of This System

The mold repair and maintenance processing is(Fig.6): ① According to the quality defect analyzing result a mold repair sheet is applied for and the mold repair period is estimated in order to aid the upper administrator to make a decision; ② Through mold repair sheet countersign it is determined that the mold is repaired on-site(if the repair period is not very long) or is exchanged with another mold (the repair period may be very long); ③ when a on-site repair project is adopt then all the panels on the same line programmed manufacturing finished time will add a delay time ; ④ when a mold replacement project is adopt then a manufacturing process simulation is needed in order to determine to exchange with which mold.

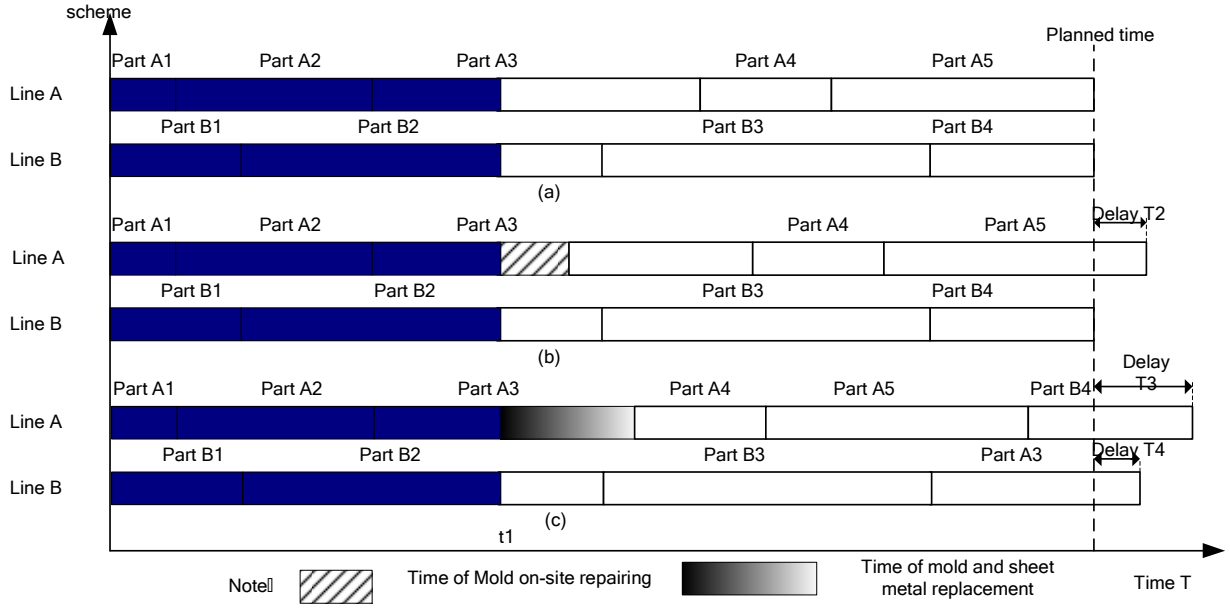

Fig.5 The Production dispatch and control process

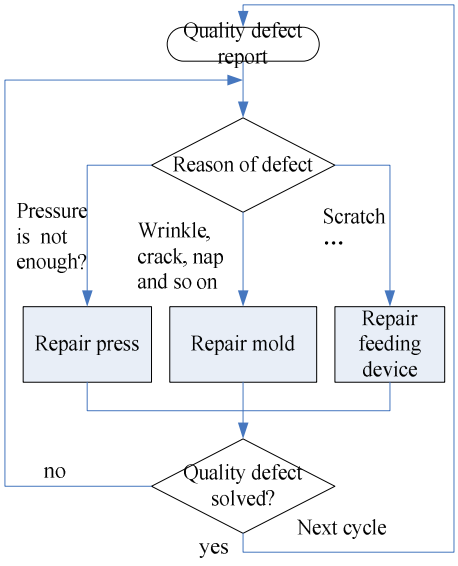

Fig.6 The Procedure of Quality Control

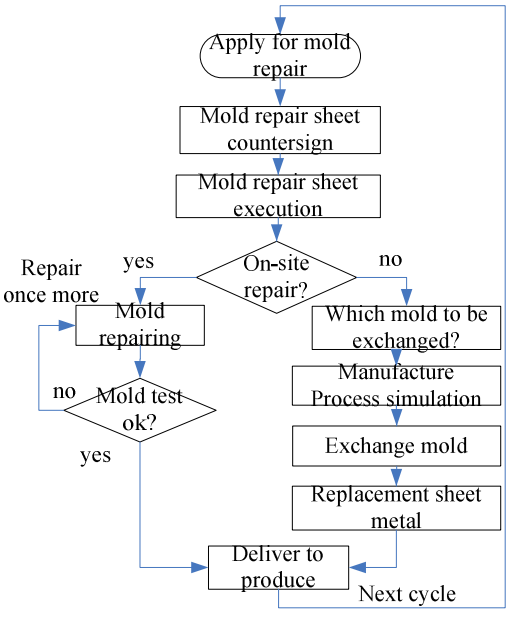

Fig.7 The Procedure of Press Die Maintain-ance

Production dispatching and controlling process is showed as following: assumed that part *A3* on production line *A* is occurring a quality defect at time *t1*(Fig.5(b)), according to Fig.7 if a on-site repair project is introduced then the part *A5* on production line *A* may append an additional *T2* delay time. If a mold replacement project is introduced according to the simulation result in order to make the total manufacturing delay time shortest part *B4* on production line *B* can be shifted to manufacturing after part *A5* on production line *A* and now the delay time of part *B4* is *T3*. The rest un-machined part *A3* on production line *A* can be shifted to manufacturing after *B3* on production line

B. Although this project may bring a delay both on part *A3* and on part *B4* but the total average manufacturing delay time is shortest. If a cross-line shifting production project is no adopt then the delay time of part *A3* will be *T3+T4* and these parts on production line will not append an additional delay time but the delay time of part *A3* is very long. So a cross-line shifting production project may be a suitable project.

Conclusion

During to the complexity of Body-In-White manufacturing process the pressing production on-site management is difficult so a pressing production on-site management system has been developed in order to make the upper *ERP/CAPP/PDM* planning more executable. The detailed function model of this system such as task assignment, quality control, mold maintenance and production scheduling has been thoroughly discussed. In order to make the production line capability balance the workshop task dispatching algorithm has been given and the dynamic dispatching and controlling process has been explained. This system can be integrated with the upper *ERP/CAPP/PDM* system which can improve the information level of a company.

Acknowledgments

This paper is supported by Xiamen Economic Development Board Research Foundation of China (No. 2009J0009).

References

[1] J.R.Xiao. Pressing Process Theory. (Mechanic Industry Press, China 2002) . (in Chinese)

[2] Y.Z.Chen, J.P.Lin, C.Q.Q. Transactions of the Chinese Society of Agricultural, Vol.128-132(2006),p.9. (in Chinese)

[3] Y.Q.Rao, C.J.Zhu, C.Y.Zhang. Computer Integrated Manufacturing, Vol.1120-1125 (2003), p.9 .(In Chinese)

[4] C.Y.Zhang, Y.Q.Rao, B.Wu. China Mechanical Engineer, Vol.1333-1338 (2004), p.8.(in Chinese)

[5] P.Zhang, N.Sun, F.Hou. Computer Integrated Manufacturing, Vol. 1732-1738(2007), p.9. (in Chinese)

[6] J.Y.Shi, D.F.Yue. Machinery Design & Manufacture, Vol.166-168(2006), p.3. (in Chinese)

[7] H.J.Liu, J.Li, Y.Q.Zheng. Journal of Tongji University, Vol.534-539(2006), p.4. (in Chinese)

[8] J.F.Chang, Y.X.Zhong, Z.D.Han. Journal of Plasticity Engineering, Vol.61-67(2004), p.11. (in Chinese)

[9] S.Enjalbert, B.Archimede, P.Charbonnaud. International Journal Production Research, Vol. 6663-6676(2011), p.15.

[10] Y.C.Jiang, X.R.Gong, C.Yin. Journal of Chongqing University, Vol.71-79(2011), p.8. (in Chinese)