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Research Paper

Integration of product data to reduce duration of process configuration design cycle using CAD-A knowledge Based approach

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ABSTRACT: This paper describes a knowledge based system which helps to integrate the various product data of a printing pressline configuration. The integration of the product data reduces repetitive changes in the individual product data. Also Knowledge Based System (KBS) integrates the product data with Material Requirement planning (MRP) system of the printing pressline manufacturing company. With developed KBS mass customization concept can be implemented for a printing press manufacturing company.

Keywords:- Bill of Material (BOM), Configuration design , Knowledge Based Systems(KBS), Machine Layout, Printing Pressline, Pro-Programming**.**

I. INTRODUCTION

The concept of mass customization is widely accepted in today's competitive environment. The management in industry is seeking shortening of product development and manufacturing time cycle. Typically, the development is an iterative process, changing, due to development of computer network from local to global cooperation in order to integrate resources of knowledge and solve the conflicts caused by changes in design specifications as early as possible.

In any project based industry the production system is generally of 'make to order' type considering the customization required for the project. Customization can result into longer lead times. The reduction in the lead time will increase the productivity. In such an environment, production system has to depend on the design stage of the project. The design stage being an iterative process, affects the remaining production process. The integration of the product data management (PDM) system with enterprise resource planning (ERP) system reduces the repetitive and separate updating of BOM structures whenever CAD systems are revised.

The integration of various types of product data can be achieved by knowledge based system developed with the help of any commercial CAD software. In this work, knowledge based system is developed and implemented in a company manufacturing printing presses for newspapers. The printing press consists of number of printing modules arranged in a sequential format. This sequence is decided in consultation with the customer and the main input for the finalization of the sequential layout is the configuration layout. Apart from the main configuration layout there are other subsidiary layouts such as structural layout, connecting layout, foundation layouts etc. All these subsidiary layouts are dependent upon the main configuration layout and any change in the configuration layout calls for updating of the subsidiary layouts also. The configuration layout data also serves as the input for the MRP system. With the conventional system of working all the iteration are required to be carried out manually for different subsidiary layouts.

Therefore, integration of product data using CAD has become an important way to improve productivity of design process.

Owing to the importance of KBE, a growing number of research activities in these areas have been observed in recent years. (Hren and Jezernik, 2001) mentioned the importance of design automation in view of improving efficiency in the design process for mass customization. This study stresses upon integration of design and manufacturing knowledge.

(Lin B et al., 2008) developed a knowledge based system (KBS) which automatically selects the progressive die design components. The KBS was developed using Pro-E commercial CAD software and the Pro-Programming language. A user interface was developed in Pro Toolkit module. Similar work is also reported by (Naranje V. and Kumar S.2010)who developed a low cost knowledge based design system for progressive die design. The KBS was developed in AutoCAD and AutoLISP programming language. Development of such KBS includes various steps such as knowledge acquisition, framing of production rules, verifications of production rules, selection of knowledge representation language, identification of hard-ware, development of a knowledge base and construction of user interface. Such type of knowledge base system essentially requires a CAD system, A user interface and inference mechanism to correlate the rules. (Muyung S and Han S. 2001) developed knowledge based system for design of machine tool parts. The machine tool heads and main components are automatically selected by knowledge based system.

(Wei et al, 2008) analysed characteristics of ERP and PDM integration. The study recognizes ERP and PDM systems as heterogeneous systems. It also highlights the difficulties in integration of two heterogeneous systems. The characteristics such as computer architecture requirements, database management systems (DBMS), and fundamental operating systems are different for ERP and PDM. Further they proposed a new technology for heterogonous data translation, named business remote function cell. (Chapman C and Pinfold M,2001) developed a KBS named Design and analysis and response tool which enables automatic meshing of the automotive body parts negating separate modeling of the geometry for analysis purpose.

The research so far, appears to be more focused on elimination of waste in component design process. There is considerable amount of work carried out for improvement of assembly systems, but the research in the area of configuration design process is not reported.

II. KNOWLEDGE BASED SYSTEM FOR SELECTION OF PRINTING PRESS CONFIGURATION:

Newspapers are generally printed on offset printing machines. During printing of a newspaper, number of machines is related with number of pages in the newspaper. Each page is printed separately and after printing all pages (webs) are combined together at the folder station and are later cut into individual newspaper copy. The entire printing process has variety of features starting from color control to cut off control. These features are entirely dependent on the customer requirements which cause changes in design from customer to customer. The requirements of the customer that which types of features customer needs are primary inputs which decides the total machine configuration. Once the configuration layout design is finalized, the design department has to prepare various other layouts e.g. machine layout, gallery layout, driveline layout, foundation layout. The Bill of Material (BOM) is prepared separately for each layout.

2.1 Present Practices:

Presently layouts of printing pressline are revised manually and changes in product data are also managed manually for every revision. There are five types of different Layouts are required to be finalized for each customer. Out of five layouts four layouts are dependent on the basic Machine configuration layout. While finalizing the project specifications with the customer, often it was observed that there are many iterations with the machine layouts. Each iteration of machine configuration layout also forces the iterations in the other four layouts. Presently all these iterations are carried out independently. With each revision of the product layout, the MRP system needs to be managed separately. This causes lot of repetitive work and consumes considerable time of technical staff.

2.2 Objectives:

Considering this situation, with a view to reduce the waste in configuration design process a KBS using CAD is proposed in this work. The objectives of the proposed system are,

(i)To integrate various product layouts of printing press line, using a CAD software package

(ii)To automate the iteration process by using the KBS

(iii)Integration of product data with MRP using CAD software to eliminate the repetitive work due to product layout revisions

III. METHODOLOGY

The methodology to develop a knowledge based system is as follows:

3.1 Data Collection

All printing parameters which decides printing configuration are collected. Also there are different printing possibilities a customer may needs. These printing possibilities lead to finalization of the configuration hence all such printing possibilities which are in frequent demand are collected.

3.2 Identification of the standards Layouts

All the varieties of the configuration have been studied for representation using CAD. Nearly 32 different possible combinations of the layouts are identified for this purpose.

3.3 Preparing 3D models:

The 3D models of the main units such as folder unit, print unit and unwinder unit are prepared with all possibilities of the cases are prepared using Pro-E commercial CAD software. A sketch of the main Print Unit is shown in figure 1

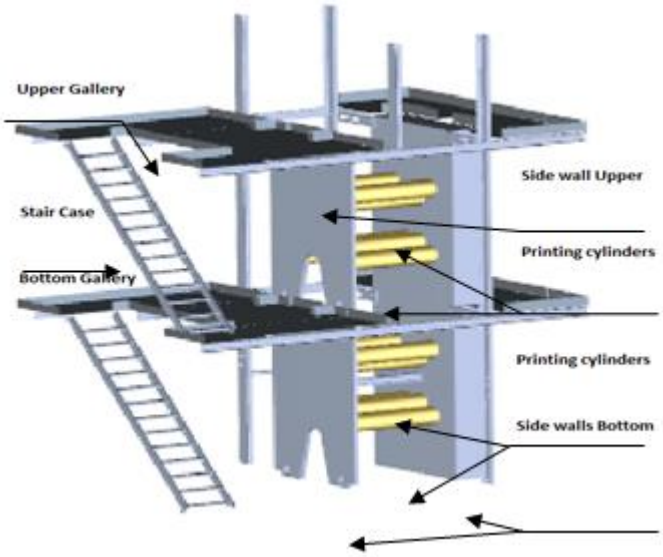

Fig. 1. 3D model sketch of Main Print Unit.

While preparing 3D drawings, models are prepared under two categories: i)Components which are dependent on the configuration ii) Components which are independent of the configuration changes. The first category component includes parts such as drive line shafts, sheet metal covers of driveline, structural components, sheet metals for walk ways etc. The second category components are Main machine units such as Printing press Module, Reel Splicer Module etc After completing the individual assembly of main units, all units are linked to each other in main assembly by recognizing all possible combinations of the print units and allied units.

A knowledge based system comprises three main parts, (i) CAD system, (ii) user interface and (iii) inference engine to correlate the knowledge rules. Different CAD software programs can be integrated with the different inference engines as per requirement. Pro-Programming, an inbuilt programming module in the commercial CAD software Pro-E, is provided for the integration of the decision rules with the CAD module. The framework of proposed KBS is shown in figure 2.

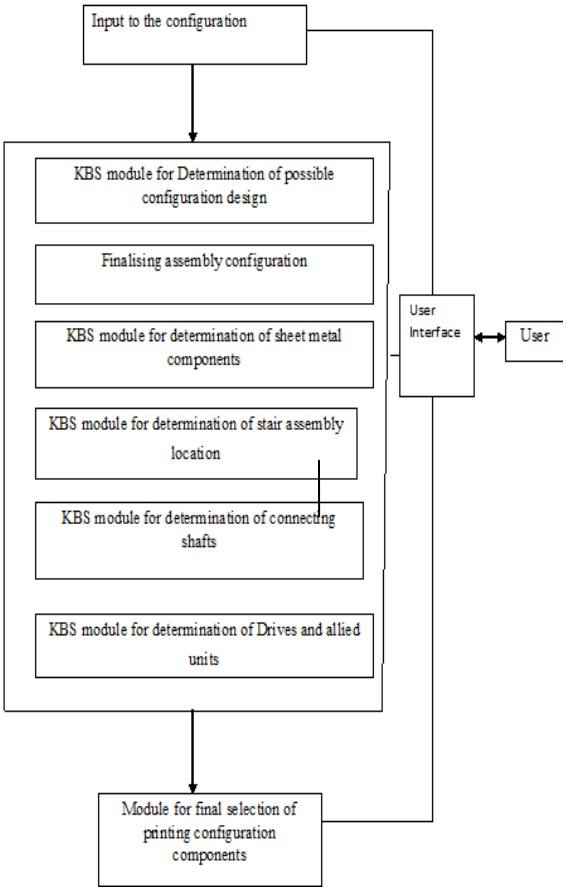

Fig. 2. Proposed KBS framework for printing pressline configuration design.

3.4 Development of Knowledge Based System Framework

Pro Programming was selected for defining decision rules and integrating it with the CAD software. Considering all possible combination of the cases the programming rules are defined using "If-Else" conditions. Firstly all possible combinations of the assembly parts are written as per the different cases.

For example, a staircase will be offset when two main print units are arranged immediately after each other; else the staircase will remain same as shown in figure 1.

Programming is the process of converting the relationships of the parameters and geometric operations into different cases. The relationships of the parameters must meet all design criteria and standards. The input is defined as pairs in programming. The pairs are formed by the main print unit i.e 4 color Hiline(4HI) and the Unwinder(UW). Also pairs are defined as per reference with the folder (F). Inputs needs to be firstly defined and then can be used for specifying the conditions.

A simple program to add some specified parts for two cases is shown in figure 3. The condition is the Pair 1 may be coupled with HI-UW or HI-HI. For this the program can be written as below.

```
IF PAIR1 == "4HIRS"
    ADD SUBASSEMBLY REELSPLICER
    INTERNAL COMPONENT ID 40
    PARENTS = 39(#5)
    END ADD
 END IF
 IF PAIR1 =="4HI4HI"
    ADD SUBASSEMBLY BASICTOWER
    INTERNAL COMPONENT ID 45
    END ADD
    ADD PART CHKERPLATEMIDDLE2T
    INTERNAL COMPONENT ID 52
    END ADD
    ADD PART CHCKETOP2T
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```
    INTERNAL COMPONENT ID 61
    END ADD
 END IF
 IF PAIR1 == "4HIRS"
    ADD PART CCHANNEL
    INTERNAL COMPONENT ID 70
    PARENTS = 39(#5)
    END ADD
    ADD PART CCHANNELUPPERSI
    INTERNAL COMPONENT ID 71
    PARENTS = 39(#5)
    END ADD
            ADD PART APSIICHCKER2
            INTERNAL COMPONENT ID 109
PARENTS = 70(#7)
  END ADD
  END IF
```

Fig. 3 Program to add specified parts for two cases

Once the programming is completed the inbuilt user interface interacts with the user with series of questions this is based upon type of inputs. A sample input is shown in figure 4. The interface asks the information of 1st web pair which is couple of the main print unit and unwinder. The positions may be 4HIRS OR 4HI4HI.

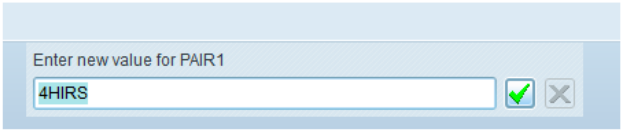

Fig. 4. Interface for Input module Entry

3.5 Coding system for the configuration:

In order to facilitate proper access to the any configuration which is previously send to the customer, A coding system is proposed. It consists of a 15 digit code. Every digit gives information about the specific location. The configuration code is developed in spreadsheet application. The code can be very useful for the further reference when deciding configuration for the new customer.

IV. RESULTS AND DISCUSSIONS

The knowledge based system after getting the inputs analyses the different decision rules in the programming and then the positions of the units are decided. The output comes in same CAD file. Similar conditions can be applied for multiple cases and desired part location can be achieved by using the Pro-Program. By using Pro- Program two configurations are achieved and are shown as below

Configuration A-
4HI UW 4HI UW 4HI UW F 4HI UW 4HI UW 4HI UW
Configuration B –
4HI 4HI UW UW 4HI UW F 4HI 4HI UW UW 4HI UW
These two possible combinations are shown in figures 5 and 6 respectively. The system provides following outcomes.

i) The repetitive iteration work is eliminated which contributes to the majority of rework.

ii) Different types of the subsidiary layouts get combine into a CAD data which enables integration of all layouts. Thus any change in the main configuration layout is automatically updated in all different types of layouts.

iii) The Product data is also integrated with the BOM system of the CAD. This integration eliminates the need of frequent updating of the BOM system.

V. CONCLUSION

In this work, a method of integrating number of configuration layouts of the printing press is proposed. The proposed system can finalize the configuration based upon various input conditions. The integration of the BOM with product data eliminates errors of material requirement during the assembly process which occurs during manual updating of the MRP as per changes in the main configuration layout. The coding system allows proper data management and any newly designed layout can be referred with old database quickly.

There are some areas where existing system can be improved. With existing knowledge based system the user has to enter into the software environment which is not user friendly hence a user interface can be developed which allows direct access to the CAD data.

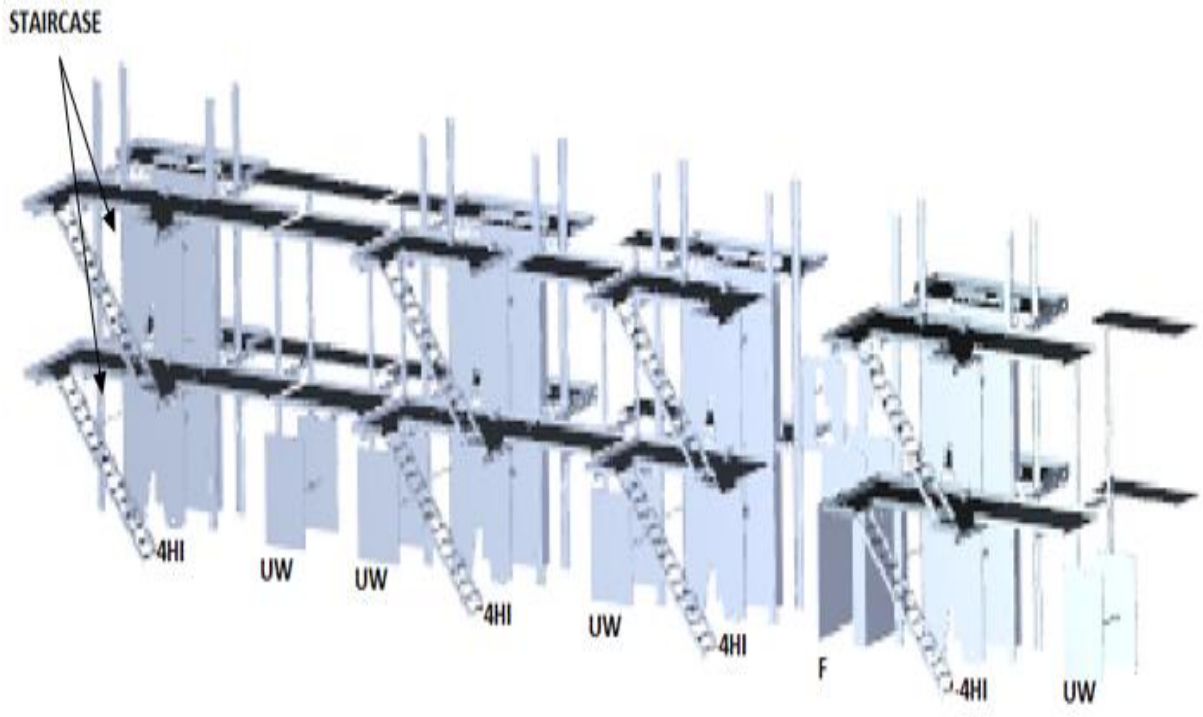

Fig. 5 "A" type configuration layout

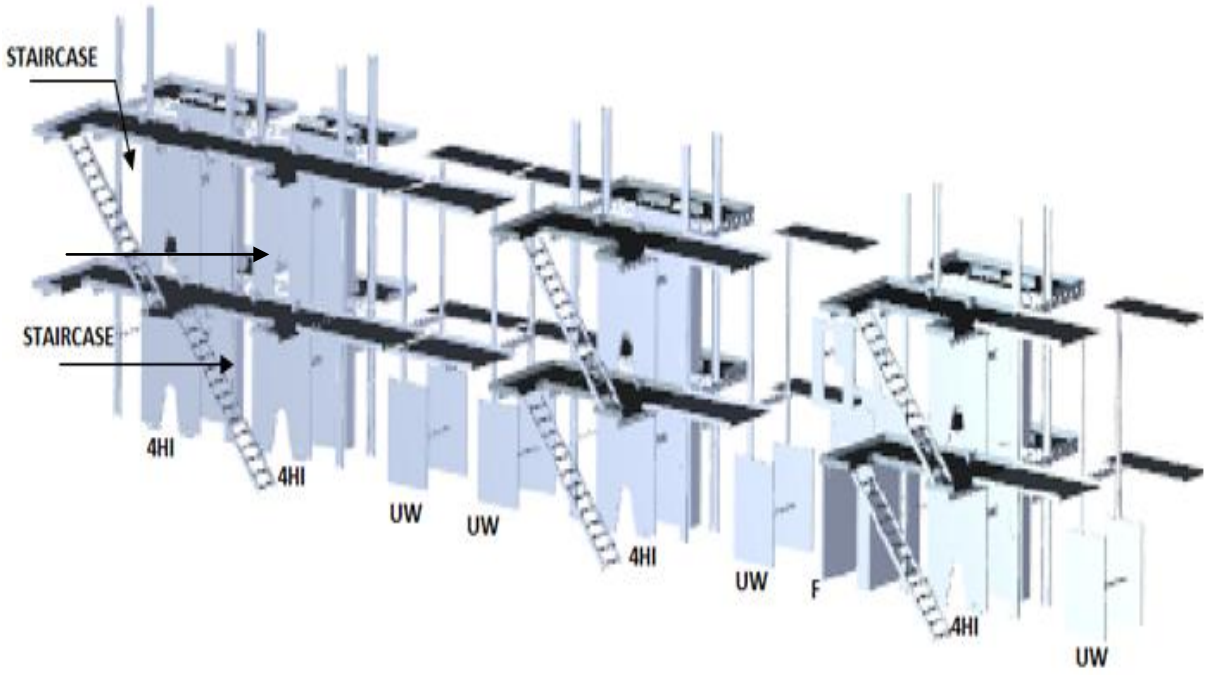

Fig. 6 "B" type configuration layout

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