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Automotive Body in White Framing Systems Review

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ABSTRACT

One of the main assembly processes in Body Shop produce BIW (Body in White). Automated framing system is used to assemble main sub assembly of body parts to become a BIW. Among the challenges using BIW framing are high investment, change of model or product life cycle and multiple or mixed model in a single line.This paper conducts a systematic review on BIW framing systems for automotive scope. Study and compare on the framing systems used have been carried out. Some examples of different BIW framing systems are shown. The current trend indicates t hat the framing systems changed from dedicated model to multiple models which seek flexibility approach to add in. Major or big automotive OEM's have their own design of BIW framing system.

Keywords: Manufacturing; automotive; framing systems

INTRODUCTION

Framing is required in order to prevent something placed outside the boundary. Body in white (BIW) framing generally as a 'jig' for holding equipment and chassis parts prior to complete installation process to become a Complete built unit (CBU). Therefore, requirement to meet BIW quality is very important in order to ensure final CBU quality is good.

TYPE OF BIW FRAMING

Among framing system types are Two slider framers, robot change framer, separated type robot framer, One-body type robot framer, Manifold cylinder framer, Roof robot framer, Sliding framer system (Open-gate system) and Index framer (Source: from one of jig maker). Each type has their advantage and disadvantage points. Among the advantages are flexible to model, phased equipment installation, short new model introduction time and short operation time. While the biggest disadvantage factor is cost. Selection of type depends on OEM (Original Equipment Manufacturer) preferable.

BIW FRAMING AND MASS CUSTOMIZATION

Over the past few years, manufacturing sector or industry is facing more challenges and become complex for new era industrialization which have to suit many requirements but with reducing manufacturing cost and time. BIW framing also affected with current requirement on mass customization production approach. (K. Efthymiou et al. 2012) described approach on manufacturing complexity by providing an analytical assessment method.

BIW FRAMING IN AUTOMOTIVE INDUSTRY

DEFINITION

'Framing system' is a process and the related infrastructure for a precise positioning and securing under-body platform with the upper body components (Baulier 2006).

CURRENT STATUS

In current automotive scenario, competition is high which seen model life cycle actively changed. BIW framing needs more flexibility if it wants to share the same line for multiple models. Figure 1 shows an example of different styling but the challenge to communize the BIW framing makes it hard to manufacture them at the same line.

FIGURE 1. Audi models with different styling

BIW FRAMING APPROACHES WITHIN THE WORLD

THE PLATFORM CONCEPTS

As a base or foundation, platform is required as a common infrastructure for various product types. It covers common components, processes and interfaces which contribute to a final product and can also add unique elements to product platforms (A. Al-Zaher et al. 2013).

There is a relation between flexibility and platform. It is because from an academic point of view, flexibility as a metric of the system's behavior can be shown in many forms, subject to the system's requirement. Product, operation, process, volume, expansion, and labor are identified as some types of flexibility which can be proposed (Michalos et al. 2010). According to Michalos et al. as a total scenario, a design of an assembly system can be recognized either manual, flexible, semi-auto or fixed assembly which can assemble a variety number of vehicle variations (models and versions).

THE ASSEMBLY COMPONENTS

JIG AND FIXTURES

Stamping parts or panels need to be hold during assembling process. Therefore, jigs and fixtures are required to hold the panels. As time goes by, the fixturing building approach has been innovated. At the early stage, small unit parts were used to expand to large unit by sequential welding in jigs/fixtures which has been designed for dedicated model of body. The parts were clamped with complex manual toggle clamps fixtures or through an integrated pneumatic clamping system. Figure 2 shows a sample of jig assembly components for assembling of roof panel.

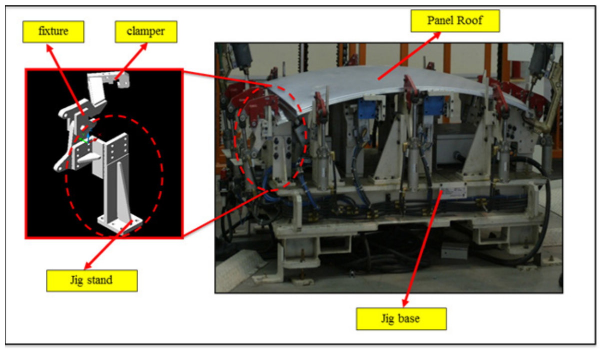

FIGURE 2. A Panel roof assembly jig

MAIN ISSUES

A major disadvantage encountered when using BIW framing, for example high investment, change of model or product life cycle, multiple or mixed model in a single line, bulky in size, and rigid design. Therefore, as a framing system was designed as per particular model; when a requirement on increasing productivity and producing good quality product, flexibility of framing jig has been turned into priority need. A new model introduction requires manufacturing industry to make refurbishments on their assembly line. Three proposals can be considered. Either to stop production and change the old line with a new one, build a new line in a new area, or change the manufacturing line for incoming models without stopping the current model. The best approach for the manufacturer is the third approach because it has a flexibility element for reasons as follows:

1. To improve mixed production.
2. Enormous investment for change over when the model is changed.
3. Stoppage of manufacturing lines prior to change over.
4. Surplus tied up production capacity during phasing out of model.
5. Huge manpower to change the layout and installation of new equipment.

EXAMPLES OF AUTOMOTIVE BIW FRAMING

Most of the major or top OEM develop their own BIW framing. Here are some of the examples from OEM (Drishtikona 2010).

RENAULT

The framing system is called as Preciflex which consists of 3 different integrated frames i.e., lower, upper front and upper rear frames. At the early development, the framing system can only accommodate for one model but it has then been enabled for the multiple model production.

TOYOTA

Flexible Body Line (FBL) is the name of Toyota's framing system. The system inclusive of jig circulation method. It was also developed through off line programming, (OLP) using CAD/CAE program. Besides that, Toyota also had developed their own in-house software.

NISSAN

Intelligent Body Assembly System (IBAS) is the name of Nissan's framing system. It comprises of 3 stages i.e.:

Stage 1: Sub assembly on separate areas; for example, Rear floor, Front end, Side structure etc.

Stage 2: All sub assembly parts are transferred to main body framing line using shuttle and guided by NC locator. At the main body framing, joining process for all parts are done through spot welding by robot.

Stage 3: The complete main body is measured using sensors.

BIW FRAMING DESIGN REQUIREMENT

Based on Al Zaher et al., for BIW framing design requirement, it needs to consider how easy it is to modify the framing if they were to add or change a model and possibility to increase range of production life system which embedded adaptability approach in the framing system.

DISCUSSION AND CONCLUSIONS

In general, some of BIW framing systems within the automotive industry have been reviewed in this paper. Major or big automotive OEM's normally have their own design of BIW framing system which has the advantage of designing a system to suit their requirement and can manage future changes properly. For small automotive industry, weighted matrix approach can be used for the selection of BIW framing system type.

For example, Volkswagen (VW) group created a special platform which is called MQB (Modularer Baukasten / Modular Matrix) platform. Under VW group which have several models i.e., VW, Audi, Skoda and Seat; by implementing MQB platform, it can produce about 30 variants of models among their group. It is not an easy job to produce more than one model using the same platform. Therefore, finally, to counter the main issues in manufacturing complexity which is to assemble more than one model in the same assembly line. Among the approaches are platform strategy, adopt manufacturing flexibility and RMS (Reconfigure Manufacturing System) / RAS (Reconfigure Assembly System) concept.

More examples of simulation and reconfigurable approaches can be found in (Vlatka Hlupic et al. 1999; Enrico Briano et al. 1972; T.S. Mujber et al. 2004; Pam Laney Markt 1997; Anthony Waller 2012; M.G. Mehrabi et al. 2000; Z.M. Bi et al. 2008; Hoda A. ElMaraghy 2006; Mohamad Zamri Md Zain et al. 2017; Jianfeng Yu et al. 2003; Mohammad Reza Abdi & Ashraf W. Labib 2003; Hitendra et al. 2006; Svetan M. Ratchev et al. 2007; Z.M. Bi et al. 2004; George Michalos et al. 2016; Edward J. Williams & Haldun Celik 1998; Z.M. Bi, Lihui Wang & Sherman Y.T. Lang 2007; Juhani Heilala & Paavo Voho 2001; Z.M. Bi et al. 2008; K.K.B. Hon & S. Xu 2007; Raed El-Khalil 2015; J. Pandremenos et al. 2009; G. Michalos et al. 2015)

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DECLARATION OF COMPETING INTEREST

None.

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