Optimization design of rear door car fitting jig by using design for manufacturing and assembly approach – Boothroyd Dewhurst DFA method

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ABSTRACT – This study presents the execution of Design for Manufacturing and Assembly (DfMA) in product development process. Rear door car fitting jig was chosen as a case study in this study. The study intends to improve the design of rear door car fitting jig by simplifying from its original design. The DfMA method was utilized as it is a well-established approach for improving the efficiency of the product and minimizing production costs as well. The result shows that the percentage of the design efficiency of existing rear door car fitting jig is 2.61%, whereas it is 2.77% of re-design rear door car fitting jig. Therefore, the re-design rear door car fitting jig is greater than the existing one. The increasing even was not so much but it was a good result because it would cut the time taken and costs to the manufacturer. It can be concluded that DfMA is a useful approach to reduce the cost of the product by simplifying the original design.

1. INTRODUCTION

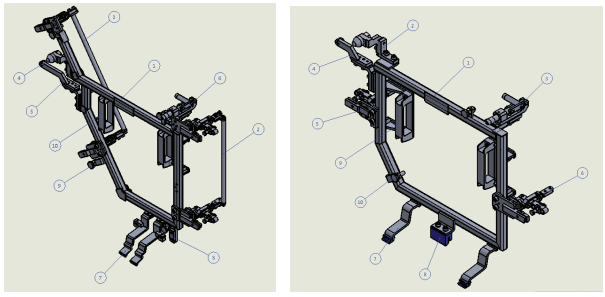
Design for Manufacturing and Assembly (DfMA) is an entrenched in product design for limiting creation expenses and improvement time by planning items into using the easiest segments. DfMA is a viable plan approach that takes into account early thought of assembling and get together part of creation as it is a blend of Design for Manufacturing (DfM) and Design for Assembly (DfA) methods. According to Boothroyd et al. [1], DfA centers around the part union for simplicity of gathering measure then, DfM centers around decreasing the assembling cost.

There are many announced case of the use of DfMA for the plan improvement from the creation perspective. Prakash et al. [2] upgraded a liquid stream control valve to acquire an ideal plan answer for a current item through serious utilization of DfMA all through the item improvement stage. Sula and Bălc [3] introduced aftereffects of the effective approval cycle of an update metering siphon utilizing the DfMA technique. The update cycle was performed by leading DfA examination on the metering siphon. The outcomes indicated that the upgrades abbreviate the gathering cycle, however it likewise smoothed out the item molded. Robert et al. [4] analyzed the quantity of parts that the calculated (the item engineering based technique) and post-plan (Boothroyd and Dewhurst) DfA investigations produce during an overhaul contextual analysis. A hard core stapler is considered for their situation study. The outcome structure that review infers that the two techniques lead to part check decrease. Barbosa and Carvalho [5] introduced a tweaked explicit apparatus for DfMA application in flight ventures. They infer that, for being a particular and redone instrument for aviation ventures, the DfMA rule for designers can help the ID direction to the answers for assembling issues, generally troublesome distinguished before creation. Didi Widya Utama et al. [6] introduced the utilization of cam strategy in clipping framework quickens and improves the way toward bracing itself so it decreases a cycle systematic time.

Despite the fact that, there are numerous specialists done the examination work dependent on utilization of DfMA in different applications yet there is as yet restricted investigation completed to improve the back entryway vehicle fitting dance utilizing DfMA in the writing. Along these lines, this examination introduced the usage of DfMA in improving back entryway vehicle fitting in item improvement measure.

2. METHODOLOGY

Rear door car fitting jig was selected as a case study in this study. Figure 1(a) shows the existing design and then was evaluated by using Boothroyd-Dewhurst DfA method. The data was analyzed and the parts for modification were proposed. The redesign parts as shown in Figure 1(b) were revaluated using the same process. The results between the original and the improved design were compared. The overall process involved in this study as shown in Figure 2.



(a) (b)

Figure 1 Existing rear door car fitting jig (a) and re-design rear door car fitting jig (b) main assembly.

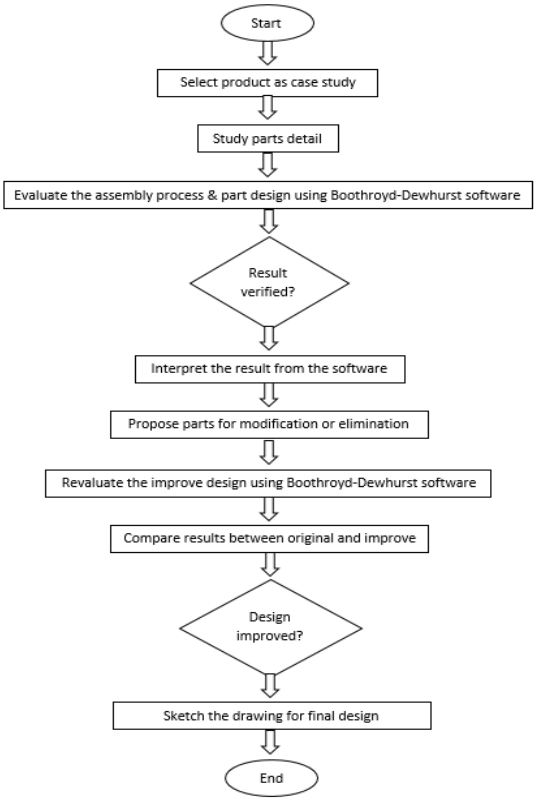


Figure 2 Flow chart of methodology.

3. RESULTS AND DISCUSSION

The new design was analyzed using the DfA procedure and Table 1 presents the results of the existing and re-design. It can be seen that impressive results were obtained in all aspects of the manufacture of this assembly. The existing design consist of 272 parts and the re-design comprises of 183 parts. This means that the documentation, acquisition and inventory of 89 part types has been eliminated.

Table 1 Comparison data between the existing and re-design of rear door car fitting jig

	Existing Design	Re-design	Improvement (%)
Parts & unanalyzed subs	272	183	32.7
Theoretical minimum items	12	9	25.0
DfA index (%)	2.61	2.77	6.1
Process time (s)	1665.43	1171.28	29.7
Process cost (RM)	5.44	3.83	29.6
Item cost (RM)	817.30	542.35	33.6
Total cost (RM)	822.74	546.18	33.6

From the data given, the DfA index increases not much from 2.61% to 2.77%, which is increased by 6.1%. The increasing even not much but it was a good result because it reduces the time taken and costs to manufacturer. In addition, the total assembly labor time of the product is reduced by 29.7% with the improvement design. Once the process time reduced, the process cost is also automatically reduced. Finally, the total cost per product for the re-design is 33.60% lower than the existing design from RM822.74 reduce to RM546.18. it can be concluded that, when there is an increased from the original DfA index and it shows a good change for an improvement. The minimization of labor time will shortly cut the cost of product. When the cost of product minimizes, the price of product will also minimize and it good for the manufacturer.

4. CONCLUSIONS

DfMA is must-go road for product lean research and development. It is a necessary basic skill for product engineers. As an excellent designer, it is necessary to judge the necessity and rationality of each design, starting from the necessity of performance and function definition, then to the rationality or material and process selection, and then to the leaning of manufacturing and assembly production. in the end, we can present perfect product to customers, which can meet market needs. In order to achieve this ultimate goal, all companies are looking for the best way. The efficiency brings cost saving. DfMA methodology is shortcut route to realize conceptual design to functional embodiment.

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REFERENCES

[1] Boothroyd, G., Dewhurst, P., and Knight, W., 2002. *Product Design for Manufacture and Assembly,* 2nd ed., New York: Marcel Dekker.

[2] Prakash, W.N., Sridhar, V.G., and Annamalai, K., New Product Development by DFMA and Rapid Prototyping.*J. Eng. Appl. Sci., vol.* 9 no. 3, pp. 274-279., 2014

[3] Sula, S., and Bâlc, N., Redesign a Metering Pump using DFMA Techniques: A Case Study. In: *The 11th International MTEM Conference*, Romania, 17-19 October 2013.

[4] Robert B. Stone, Daniel A. McAdams, and Varghese J. Kayyalethekkel, Product Architecture-based Conceptual DFA Technique. *Design Studies,* vol. 25, pp.301-325, 2004.

[5] Barbosa, G.F. and Carvalho, J., 2013. Design for Manufacturing and Assembly Methodology Applied to Aircrafts Design and Manufacturing. *The Int. Fed. of Auto. Control (IFAC),* pp.116-121.

[6] D.W. Utama, J. Septiawan, E. Suhartono and Roby, Design Development of Fixture Model in Manufacturing Spring Shackle. In: Temu Ilmiah Nasional Dosen Teknik X-2012, *Peran Perguruan Tinggi Dalam Pengembangan Teknologi Berwawasan Lingkungan.* Fakultas Teknik Universitas Tarumanagara, Jakarta, 2012.