International Journal of Sales &
Marketing Management (IJSMM)
ISSN (P): 2319-4898; ISSN (E): 2319-4901
Vol. 5, Issue 6, Oct - Nov 2016; 1-6

International Academy of Science, Engineering and Technology
IASET
Connecting Researchers; Nurturing Innovations

REDUCTION OF ASSEMBLY TIME IN RAPMAN 3.1 3D PRINTER BY REDESIGN OF ONE OF THE EIGHT CORNERS BY USING DFMA METHOD

AHMED MOHAMED WAHBA EL HADAD & AHMAD HUMAIZI BIN HILMI

Product Design, School of Manufacturing Engineering, Unimap University, Perlis, Malaysia

ABSTRACT

Over the last few years a huge development has been made over the 3D printer. One of these achievements was the (DIY) RAPMAN 3.1 3D printer. It has some disadvantages such as the difficulties in the assembly as there are too many parts which are very similar and small. However, this research managed to overcome some of these obstacles using Boothroyd Dewhurst Design for Manufacture Assembly (DFMA) method on the RAPMAN 3.1. Parts are made using nylon and Teflon materials in the prototype. It saves a proper amount of money and time with a design efficiency of 35%

KEYWORDS: Assembly Time in RAPMAN 3.1 3d Printer, Redesign of One of the Eight Corners, Using DFMA Method

INTRODUCTION

The RepRap project was the first initiative act in the way to develop a 3D printer which is able to print any component needed at low cost, it started in the university of Bath in the UK coordinated by Dr. Adrian Bowyer, Taking into account that RepRap stands for REPLICATING RAPID PROTOTYPES which used the fused filament fabrication (FFF) which enable the machine to lay down the material in layers by the computer control in a Cartesian platform XYZ and all the produced designs released under a free software license(GNU General Public License),due to the machine ability in self-replicating the producers opened the possibility to cheaply offer the RepRap unit in the market as the first one was DARWIN released in march 2007 enabling all people and communities to create complex products with low cost and recently an open source model (OS) is developed enabling the person interested to create his own RepRap model with less than 1000$, which led to a rapid increase in the RepRaps in use from 4 to 4500between 2008 and 2011.

RapMan 3.1: Is considered one of the RipRap models

Produced by (BFB) which in fact two machines with some modification, anyway, both units use the FDM process.

Rapman 3.1: Is more for demonstration in that it has basically open-form construction so that spectators can see all of the moving parts. The positioning of the head and table is done by the slide rod and Plexiglas form.

Problem Statement

- The RipRap manual guide states that assembling RapMan 3.1 Takes around two to three days as maximum average time meanwhile it takes around 2 month to finish it.
- Every small part in the assembly is very important and easily can be missed.
- Almost too many parts with almost the same orientation without a coloring code or any identifiers which make

assembling confusing and barely possible.

- During the assembly too many parts is very hard to be attached as its position too hard to be reached.

Objective of Research

- Redesign the RapMan3.1 parts in order to be easier to assembly and to safe more time.
- Create a comparison between the old and the new efficiency table to prove the achieved progress.
- Fabricate a prototype pieces and assembling the RapMan3.1 with it.

Scoop & Limitation of Research

- Using RapMan 3.1 as case study
- Using boothroyd deuhurst methodology as the DFMA tool.
- Using light weight materials such as Nylon or Teflon as the parts in assembly.

EXPERIMENTAL

By the usage of the DFMA method we managed to obtain a proper analysis for the currently used component in order to be able to choose which part could be disposable.

RESULTS AND DISCUSSIONS

In the original parts RipRap uses a very complicated, small and confusing part in the process of assembling the RapMan3.1 unit as shown in Figure 1

Three different transparent pieces with different shapes with thickness 5mm each size 45*45mm replaced by one no transparent piece with thickness 36mm and size of 45*45mm as shown in Figure 2 and Figure 3

Using the DFMA tables the outcome results was surprising due to the money and time saving as shown in the table (**Table 1** DFMA table for the original part):

Table 1: DFMA Table for the Original Part

Name of Assembly	C1			C2	C3	C4	C5	C6	C7	C8	C9	Operation Procedure
	Part ID	α	β	No. if times the operation carried out	Manual handling code	Manual handling time per part	Manual insertion code	Manual Insertion Time per part	Operation Time [C2 (C4 + C6)]	Operation Cost (RM/sec)	Estimation for the Theoretical Minimum Parts	
1M3 X 25 CP	1	360	0	4	10	1.5	00	1.5	12	0.0249999996	0	Stand 4# M3 x 25 CP (Cap head/Allen head) bolts upright on their heads
M3 Washer	2	180	0	4	00	1.13	00	1.5	10.52	0.021916666316	0	Place a single M3 washer over each bolt
10010	3	360	360	1	30	1.95	08	6.5	8.45	0.017604166385	1	Position bolts to allow part 10011 to lower over the bolts. Ensure that the bearing recess is face down
10009	4	360	360	1	30	1.95	08	6.5	8.45	0.017604166385	0	Lower part 10009 onto the bolts

Table 1: Contd.,

M3 Washer	5	180	0	4	00	1.13	00	1.5	10.52	0.021916666316	0	Next place an M3 washer on each bolt.
M3 Nut	6	180	0	4	00	1.13	00	1.5	10.52	0.021916666316	0	Screw an M3 nut 2 to 3 turns onto each bolt
1M3 X 25 CP	7	360	0	4	10	1.5	06	5.5	28	0.0583333324	0	To hold the 10008 part
M3 Washer	8	180	0	4	00	1.13	00	1.5	10.52	0.021916666316	0	Next place an M3 washer on each bolt.
10008	9	360	360	1	30	1.95	08	6.5	8.45	0.017604166385	0	Lower part 10008 onto the bolts
M3 Washer	10	180	0	4	40	3.6	16	8	46.4	0.09666666512	0	Next place an M3 washer on each bolt. By using tweezers
M3 Nut	11	180	0	4	40	3.6	16	8	46.4	0.09666666512	0	To tighten the 10008 part. By using tweezers
									TMA 200.23	RM 0.417145826659	1	

Salary for average worker in Malaysia is RM 1200 per month. Work for 8hours a day. For 5 days a week.

For one sec = 0.0020833333

Design efficiency = 3 NM/TM

= 3 * 1 / 200.23 ORIGINAL

= 0.0149 = 1.5% ORGINAL

3 * 1 / 8.45 = 0.355 = 35.5 % BETTER PRODUCT

CONCLUSIONS

Many trails and experiments were performed to test how functional the new manufactured pieces will be

As we get the results 35.5% better product and more

As for the time test we get that we save around 192 sec at every piece which propotionally save cost by around 0.3995418 cent per piece.

This new values were in acceptable range compared to the old pieces.

It was very obvious that the DFMA is very beneficial regarding the developing on RapMan 3.1 in saving time and cost, making it way easier to assembly, as it also guarantee the same results if applied over the pieces left.

However, using the new pieces will open new ways in the 3D printing field as it make it easier and more efficient.

In conclusion, RapMan 3.1 was considered very hard unit to build and assembly because of the very confusing similar parts but by using the new manufactured pieces using the DFMA it became more saving for money and time

ACKNOWLEDGEMENTS

This research is supported by unimap support and efforts, as also grateful for bits from bytes corp.

REFERENCES

1. Abe, F., Santos, E.C., Kitamura, Y., Osakada, K. and Shiomi, M., 2003. Influence of forming conditions on the titanium model in rapid prototyping with the selective laser melting process. *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, *217*(1): 119-126.
2. Asberg, B., Blanco, G., Bose, P., Garcia-Lopez, J., Overmars, M., Toussaint, G., Wilfong, G. and Zhu, B., 1997. Feasibility of design in stereolithography. *Algorithmica*, *19*(1-2): 61-83.
3. Ashley, S., 1995. Cutting costs and time with DFMA. *Mechanical Engineering*, *117*(3): 74.
4. Crane, N.B., Onen, O., Carballo, J., Ni, Q. and Guldiken, R., 2013. Fluidic assembly at the microscale: progress and prospects. *Microfluidics and nanofluidics*, *14*(3-4): 383-419.
5. Biever, C., 2005. 3D printer to churn out copies of itself. *New Scientist Magazine*.
6. Boothroyd, G., Dewhurst, P. and Knight, W., Product design for manufacture and assembly, 2002.
7. Boothroyd, Geoffrey, P. Dewhurst, and W. Knight. "Product design for manufacture and assembly, 2005."
8. Boothroyd, G. and Knight, W., 1993. ‘Manufacturing À La Carte: Efficiency: Design for assembly. *IEEE Spectrum*, 51-53.
9. Boothroyd, G., Dewhurst, P. and Knight, W.A., 2010. *Product design for manufacture and assembly*. CRC Press.
10. Causey, G.C., Quinn, R.D. and Branicky, M.S., 1999. Testing and analysis of a flexible feeding system. In *Robotics and Automation, 1999. Proceedings. 1999 IEEE International Conference on* Vol. 4, 2564-2571.
11. Chua, C.K. and Leong, K.F., 2003. *Rapid prototyping: principles and applications* Vol. 1.
12. Clark, K.B. and Wheelwright, S.C., 1995. The Product Development Challenge: Competing Through Speed, Quality, and Creativity. A Harvard Business Review Book.
13. Dewhurst, N.P., 2010, June. DFMA the product, then lean the process. In*Proceedings from International Forum on Design for Manufacture and Assembly*.
14. Bechthold, L., Fischer, V., Hainzlmaier, A., Hugenroth, D., Ivanova, L., Kroth, K., Römer, B., Sikorska, E. and Sitzmann, V., 2015. 3D Printing.
15. Helicopters, A., by Honeywell, B., Austria, F.A. and Martin, L., sae corPorate learninG clients.
16. Farhan, A.R., 2010. *Cost reduction study of automotive part using DFA method headlamp* (Doctoral dissertation, Universiti Malaysia Pahang).
17. Fox, S., Marsh, L. and Cockerham, G., 2002. Constructability rules: guidelines for successful application to bespoke buildings. *Construction Management & Economics*, *20*(8): 689-696.
18. Gibson, I., Rosen, D.W. and Stucker, B., 2010. *Additive manufacturing technologies.* New York: Springer. (1-3).
19. Bai, S., Liu, J., Yang, P., Huang, H. and Yang, L.M., 2016, International Society for Optics and Photonics. April. Femtosecond fiber laser additive manufacturing of tungsten. In *SPIE LASE*. 97380U-97380U.

20. Hooper, S., 2005. The Machine That Can Copy Anything, CNN Online, June 2.

21. Hopkinson, N., Hague, R. and Dickens, P. eds., 2006. *Rapid manufacturing: an industrial revolution for the digital age*. John Wiley & Sons.

22. Kahve Coffee Maker and E.Spring water filtration system (http://www.dfma.com/resources/abgcoffee.htm)

23. Kelly, J.F. and Hood-Daniel, P., 2011. *Printing in Plastic: Build Your Own 3D Printer*. Apress.

24. Kovalchuk, J.P.B., Canciglieri Júnior, O. and Batocchio, A., 2006, May. Concurrent Engineering application on the development of parts for the White Goods industry in Brazil--a case study. In *Proceedings of the 2006 conference on Leading the Web in Concurrent Engineering: Next Generation Concurrent Engineering*. IOS Press. 805-817.

25. Kovalchuk, J.P.B., Canciglieri Júnior, O. and Batocchio, A., 2006, May. Concurrent Engineering application on the development of parts for the White Goods industry in Brazil--a case study. In *Proceedings of the 2006 conference on Leading the Web in Concurrent Engineering: Next Generation Concurrent Engineering*. 805-817.

26. Lipson, H. and Kurman, M., 2013. *Fabricated: The new world of 3D printing*. John Wiley & Sons.

27. Lipton, J.I., Cohen, D., Heinz, M., Lobovsky, M., Parad, W., Bernstien, G., Li, T., Quartiere, J., Washington, K., Umaru, A. and Masanoff, R., 2009, August. Fab@ home model 2: Towards ubiquitous personal fabrication devices. In *Solid freeform fabrication symposium* No. 2: (70-81).

28. Malone, E. and Lipson, H., 2006. Freeform Fabrication of Complete Devices: Compact Manufacturing for Human and Robotic Exploration. In *AIAA Space*.

29. Mammoth stereolithography, Technical specifications. (http://www.materialise.com).

30. Melchels, F.P., Domingos, M.A., Klein, T.J., Malda, J., Bartolo, P.J. and Hutmacher, D.W., 2012. Additive manufacturing of tissues and organs. *Progress in Polymer Science*, *37*(8): 1079-1104.

31. Mellvyne, S., 2007. Design For Manufacture And Assembly (DFMA) Evaluation Of Car Audio Front Panel.

32. Muhammad Izwan, I., 2009. Statistical Analysis Of The Rapid Prototyping 3D Printer Process To Determine Accuracy.

33. Paul, D., Kelly, L., Venkayya, V. and Hess, T., 2002. Evolution of US military aircraft structures technology. *Journal of Aircraft*, *39*(1): 18-29.

34. PM, P.Z., Cole, J., Lu, H. and Weise, W., 2013. LITERATURE REVIEW 3D PRINTER..

35. Porter, D.K., 2012. Overview of Design for Manufacturing and Assembly (DFMA).

36. Rapid Prototyping: LOM. Accessed June 8, 2012. (http://www.efunda.com/processes/rapid_prototyping/lom.cfm).

37. Record, I., 2012. Participatory Material Culture Environmental Scan.

38. Self Replicating Robots and the Developing World. 5 June 2005. (http://www.KnowProSE.com).

39. Mellvyne, S., 2007. Design For Manufacture And Assembly (DFMA) Evaluation Of Car Audio Front Panel.

40. Tan, A. and Nixon, T., 2007. Rapid prototype manufacturing system. *Unpublished undergraduate paper, University of Adelaide, Adelaide, Australia*.

41. Walters, P., Huson, D., Parraman, C. and Stanić, M., 2009, September. 3D printing in colour: Technical evaluation and creative applications. In *Impact 6 International Printmaking Conference*..

42. Wirth, M. and Thiesse, F., 2014. Shapeways and the 3D printing revolution.

43. Wohlers, T., 2012. *Wohlers report 2012*. Wohlers Associates, Inc.

44. Xie, X., 2003. Design for manufacture and assembly. *Utah: Dept. of Mechanical*.