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Analysis for the Manufacturability of Mechanical Parts and its Functionality

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***Abstract* - There is always a gap between manufacturing sector and designer. Designer creativity fails at the shop floor due to manufacturing constraints. In traditional design process designer designs a product and it goes to the shop floor for production. In most of the cases either designer has to redesign the product or manufacturing engineers modified the design as the designer creativity cannot be manufactured due to manufacturing constraints. There is no reconciliation of process capabilities with design requirements. It will consume a lot of time to launch the product, which increases the lead time and also consume some revenue. Design for manufacture the methodology through which products are designed by taking manufacturing constraints in mind during design stage to reduce the lead time. Those who reduced the lead time will capture the market. In this paper an effort has been made for computer aided design for manufacture tool which can help the designer to improve the quality and design of the product at early stages .With this tool we can decide at early stage that whether this product is manufacturable with present manufacturing operations. After evaluating the manufacturability, designer may have more than one option i.e. there are different ways to manufacture it but he has to suggest the best without effecting the quality and cost. Designer can check its functionality by comparing it with the features of the rival products. Most of the products fail to satisfy the customer in terms of its function, cost and quality as the customer always wants more features with same price and quality i.e. designer creativity should match the customer's requirements with respect to its functionality also. This tool will provide enough information to the designer about the manufacturing constraints, dimensional constraints, and their functionality.**

***Keywords*: DFM, Manufacture, CAD**

I. Introduction

In today's world everybody is in race to launch the new quality products with more features to capture the market. Although daily new products are launched but some of them fail to perform in the market i.e. they become obsolete in a very short period of time. To sustain in the market everybody has to focus on the manufacturability of newly designed part and its functionality. To evaluate the manufacturability of the product we must know about all the manufacturing processes, their limitations i.e. whether this operation is feasible or not with the existing conditions. After analyzing the entire manufacturing or machining operations designer has to choose the best suited operation which can produce the new shape in terms of cost and quality. In today's world of globalization those who have the ability to launch the new product with more features and less cost can capture the market. To launch the new quality products with reduced lead time there must be integration between design and manufacturing. Integration of manufacturing and design leads to the evolution of design for manufacture (DFM).

II. Design For Manufacture (DFM)

Design for manufacture is an approach in which a designer designs the product by keeping in mind all the manufacturing operation constraints. DFM helps in reducing the design iterations which leads in decreasing the lead-time [1, 2]. Now day's customers are more aware about the new launches, i.e. due to publicity or internet. A customer can easily compare the product with other rivals with just a click of mouse on the internet. The most challenging is but the consumer want, what he is willing to pay and what the cost of rival's products is? So today most challenging is to design a product with more features and competitively priced. DFM helps in producing customer satisfaction products with minimal cost.

III. Design Of The Product

Company designs the new product on the basis of market survey. When they come to know that we have to produce a product with the following requirement they started designing the product in traditional ways. In traditional design there are following steps

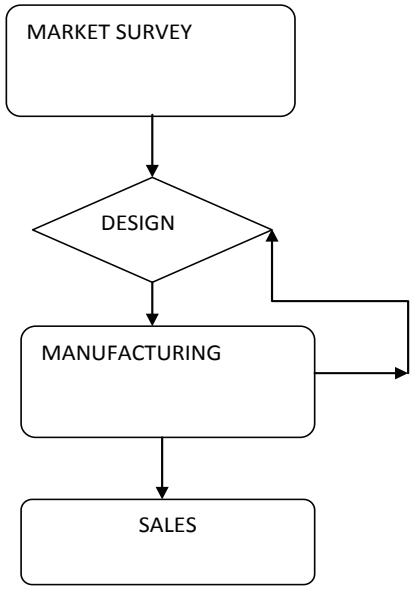

Fig. 1 Traditional Design Flow Chart

In this approach (Fig 1)designer design the product and it goes to the shop floor where variuos process plan were made to produce the product, but in most of the cases there are manufacturing constraints i.e. some operations are nor able to petform on the shop floor due to manufacturing constraints or they can be performed by alternate amchingn operation but it will incarese the cost. Thsi develops a confliction between designer and manufacturing engineers. Manufacturing team sent back the dseign for certain modification so that it should be manufacturable. These iterations dealy the launch of the poduct and also increases the lead-time and rivals launch the product in term and capture the markert.

IV. Functionality And Cost

An important consideration is to check the functionality of the final product. Functionality means the final product has all the features that consumer required at the time of launch e.g. if a mobile handset company planning to launch a handset in october 2012 in india then he must keep in mind that 3G may be the minimum requirement of the product as all the operators may slowly shifting from 2G to 3G. those who launches the product with obsolete technologies may suffer big loses as consumer are not satisfy with their functionlity. There are more examples in the literatur that if consumers are not satisfied with the functionality of the product they will fail very soon, one such example is of can lid cutter/opener. Can opener has to cut the lid without leaving any metal behind but all can openers fails the consumer satisfaction[14] as they leave some metal behind. So designer has to design the product that satisfy the purpose of theconsumer.

Another factor is the cost of the product. In earlier manufacturing system cost consist of [2,6,8,9] labor cost, material cost, manufacturing cost and overhead expenses, but vast literature shows that now a days 10% of the cost is design cost. Also there are systems which can estimate the cost of the final product at the designer stage with the help of computer software's. Designer has to check the functionality and cost at the design stage.

V. Manufacturing Processes

There are so many manufacturing processes to manufacture a product. All manufacturing operations have different operating cost. Designer has to suggest the optimal process to produce the final product which satisfies the consumer in terms of cost and quality. In literature there are so many process planning systems [5]. We have the challenge to suggest the best suited, this leads to evolution of computer aided process planning. CAPP helps the designer to suggest the process plan that must have all the possibilities of machining the parts with existing set up.

VI. Computer Aided Dfm

By implementing Computer Aided DFM (Fig 2) in industry can certainly reduce lead time.

- CONSUMER REQUIREMENTS
- DESIGN- feasibility, material selection, manufacturing constraints, process selection, quality, economic analysis, functionality
- PRODUCTION AND SALES-projected sales volume

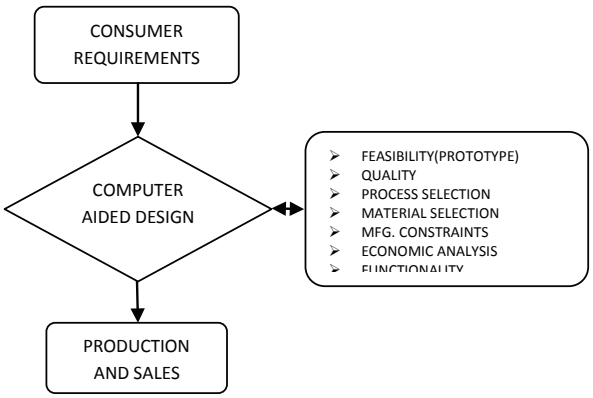

Fig. 2 Computer Aided DFM Flow Chart

Consumer Requirements: To develop a new product a detailed analysis has to prepared by every industry whether to go for new product or not. What are the market forecasts? After analyzing all the facts finally company takes the decision to launch the new product or re-launch the new product with redesign.

CAD: Earlier all the design process was manual but with the advent of computers all the industries are shifted their design stage from manual to computers. Many drafting software's are available in the market. Designers have the ease to just click on this software and to prepare blue prints. A Designer has the flexibility for modifications in their drawings with just a click of the mouse. After finalizing the drawings designer checks its feasibility [12]. Designer made 3D part of the new product and check its feasibility with the help of various analysis software's. Designer can perform various tests on the 3D drawing e.g. tensile, thermal tests etc. with the help of computer tools. Now design team is ready with all the testing results on the prototype and finally decides to develop the new product.

Next step is to develop the required product for final production. First of all quality requirements are checked. There are so many quality check e.g. strength, ease to handle, final weight, etc. A quality check leads the team to choose the required material. Material selection is another crucial step for the design team as there are number of materials but they have to choose the best with minimum cost and ease of manufacturability. After finalizing the material detailed computer aided process plan has been made. Computer aided process plan helps the designer team to check the manufacturing constraints and if there are constraints they have to go for alternate manufacturing processes. Now

product is ready for economic analysis [7]. Design Team has now enough databases to estimate the cost price per unit of the consumer product. Last step is to check its functionality by comparing it with rival products. Now industry can plan its production and sales on the basis of market forecast.

VII. Conclusion

This paper discussed the DFM methodology. It helps in estimating the manufacturability aspects with required functionality. Nortel [8] has successfully implemented DFM methodology. This analysis has the feedback for the designer about manufacturing constraints i.e. designer can redesign the product to improve the manufacturability. Most of the products use primary and secondary manufacturing processes, designer can suggest at the design stage. This type of approach is very useful in flexible manufacturing system where we have to respond quickly according to the changing demands of the customers. DFM implementation is not very difficult but this approach may help the industry to implement it.

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