

The Why and How of Design for Manufacturability Review Automation

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Introduction

'Design for Manufacturability' (DFM) is a methodology that involves designing with an intent to minimize the cost of production and time-to-market, without compromising on the quality of the product. Various studies have proved that an error detected and rectified during the design stage costs almost 100-1000 times less than when rectified at the manufacturing stage. Research also indicates that around 70% of the product cost is committed during the design stage itself.

Eli Whitney can be credited with the application of a process involving Design for Manufacturability (DFM) practices many years before the origin of the term. A book, "Metals Engineering Processes" edited by Roger Bolz and published by ASME in 1958 provided guidelines for assisting the designer in enhancing manufacturability of his designs. The term DFM became popular around 1985.

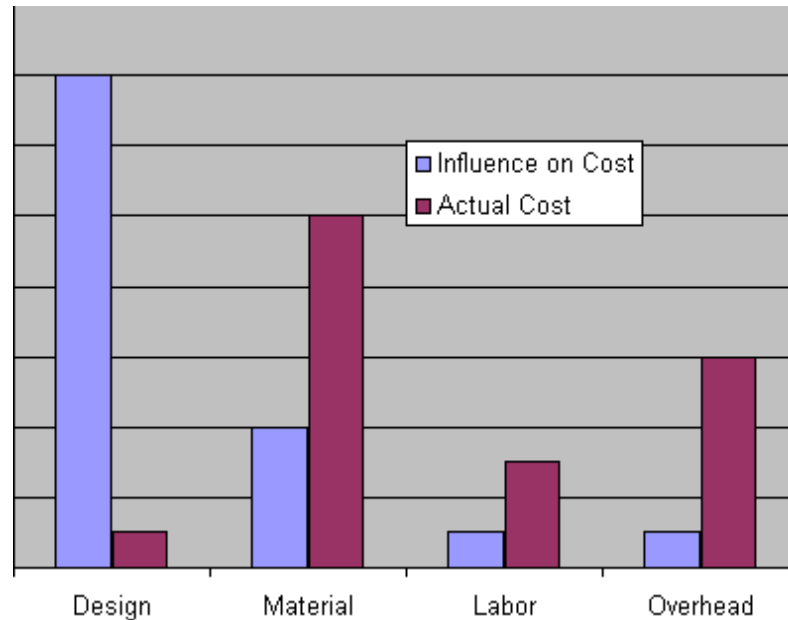


Figure 1 : Design Impact

Figure 1 clearly demonstrates that though the actual cost incurred during the design stage is the lowest; its influence on the product cost is the highest. Any decisions taken during the design stage have a cascading cost implication on the entire manufacturing process.

Organizations stand to gain a lot by adopting DFM initiatives. DFM adoption can happen in various ways. This may involve design reviews by senior design engineers who are familiar with the manufacturing processes or inputs from manufacturing engineers during the design stage itself. Organizations have practiced DFM by forming such dedicated teams with the objective of improving designs, part quality and reducing costs. The aim of such initiatives is to reduce the manufacturing cost, improve part quality and improve the time-to-market.

Challenges Faced with the Current DFM Methodology

Though many organizations have advocated DFM practices, many face hurdles in successful implementation; following being some of the reasons.

DFM principles are far too many to remember

It is impractical for a single person to review a design manually considering all the recommended guidelines. DFM principles mentioned in handbooks may not get referred to and manual use of checklists can lead to possibilities of errors.

Automated mechanism for verification of knowledge transfer is missing

It takes time and effort for manufacturing engineers to transfer manufacturing related inputs to the design team. There's no automatic verification mechanism to ensure that the inputs were incorporated in the design. This implies that the designs may have to be manually verified to validate their appropriateness.

Standards / Guidelines need to be validated and updated regularly

Standards or guidelines may have to be repeated and validated for all parts. As the organization's process capability improves over time, the guidelines need to be updated accordingly. Similarly, the standard machining tools available in the organization need to be given preference to save time as well as cost. This requires reference to the active database of tools and processes. All these activities need to be repeated for every design. Any error during the design validation early in the product creation cycle could cost a lot more problems during manufacturing.

Managing concurrent engineering teams across geographies become difficult

DFM proponents advocate concurrent engineering teams consisting of engineers from various departments like design, manufacturing, quality among others. However, managing teams is not easy. Additionally, with the global manufacturing scenario, teams are likely to be widely dispersed. For similar parts, it makes sense to have an automated process in place.

Therefore, the need of the hour is a simple, easy to use, yet powerful tool, which allows quick validation of the designs for ease of manufacturing -- automating the DFM reviews to a large extent. Consider an organization which designs and manufactures sheet metal components like trays and packings for chemical and petrochemical industries. One of the typical challenges faced is problems like rework, rejections and waste. This was mainly due to design errors leading to manufacturing and assembly errors. The manual design review process was error prone and time consuming. On deployment on a DFM review automation tool, the organization experienced around 90% reduction in time spent for DFM reviews and subsequently around 15% reduction in total times spent on product design reviews.

Benefits of DFM Review Automation

DFM related errors get detected at the design stage

A DFM review tool integrated within the CAD environment can alert the designer regarding any violation of DFM guidelines. Automation thus reduces the chances of costly design mistakes.

Ensure mistakes are not repeated, especially by newbie design engineers

Using DFM review automation and rule customization, best practices can be captured and disseminated. A single tool deployed uniformly for design reviews would promote consistency in design quality.

Support for continuous process improvement

A systematically deployed DFM review automation solution can provide a framework to capture, enforce and improve the manufacturability knowledge within the organization. The design rule parameters can be calibrated according to the organizational process requirements.

Reduce cost and time

Any rework or iteration costs the organization time and money. The DFM review software enables to save substantial time, rework and waste resulting from errors escaping reviews.

Requirements of a DFM Review Automation Software

Software aimed at automating the DFM review process completely or partially must satisfy the following minimum requirements:

DFM review software must be easy-to-use

It is critical for DFM review software to have a negligible learning curve as it aims at reducing the time required for DFM reviews.

Standard globally practiced rules must be provided as part of the default package

The primary value-add of DFM review software is to support standard rules that are well known and accepted by the concerned industries. An organization making a fresh start with DFM can use the packaged rules directly to start their preliminary investigations and then fine tune the parameters to reflect the local manufacturing setup. DFM review software has an inbuilt 'rule file' that forms a part of the packaged product.

A DFM review tool must seamlessly integrate with the CAD environment

Seamless integration of the DFM review tool into the CAD environment allows users to be comfortable with the working environment and losses in data translation are eliminated. Additionally, the DFM review software can make use of the native CAD properties for DFM checks.

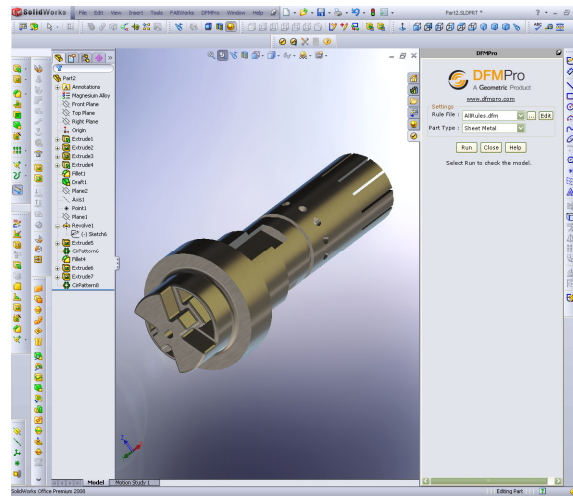


Figure 2 : DFM review automation within CAD software

The DFM review tool must support imported or native models

In addition to integration with the CAD environment, the DFM review tool must support feature extraction from imported models. This is important as the design-analysis-manufacturing communities are spread across geographies and it might not be possible for all vendors and suppliers to have the same CAD/CAM package.

DFM review automation environment must be extensible

Customers of costing software frequently complain that they need to go back to the software vendor for enhancements to processes and parameters. Ideally, the software should have in-built extension capabilities to cater to these enhancements.

DFM review customization must be easy and also support advanced scenarios

It is highly unlikely that the DFM review automation will be used by an organization without customization. Local parameters like manufacturing tools, materials, etc may drive the customization requirement starting with minor tweaking of rule parameters and advancing into rule programming

This facility allows manufacturing engineers to reuse their tool databases and connect the rule validation scripts to this data for access to live tooling data. Depending on actual requirements,

organizations can mandate adherence to standard tools or allow specialized tooling in certain cases. Validation of this rule is made easy through the automation provided by DFMPPro.

'Rule Programming' environment must be in-built

It will be highly cost-ineffective if users have to spend on a development environment in addition to the DFM review software. Hence a basic rule programming environment must be available as part of the DFM software package. Advanced users will already have a development environment setup.

DFMXpress, which ships with the recent versions of SolidWorks is one example of a DFM review automation tool that assists the user to quickly identify areas of the design which could be difficult or expensive to manufacture. It provides the user with a flavor of DFM review automation.

Conclusion/ Summary

Though a software tool is not the panacea for all kinds of manufacturing problems, an effective deployment of such an automation tool will lay the foundation for DFM improvements in the organization.

A DFM review automation tool helps in identifying areas in a design that are difficult, expensive or impossible to manufacture. It eases and reduces errors in the design validation process. It promotes adherence to organizational standards (namely, tools, processes, materials).

All in all, a DFM review automation tool saves considerable cost, time and effort by improving productivity and reducing waste.

About the Author

Rahul Rajadhyaksha is Product Manager for DFMPPro, an easy-to-use Design for Manufacturability (DFM) tool for design and manufacturing engineers developed by Geometric. Rahul is a mechanical engineer and has worked with many CAD/CAM packages. He has product development and product management experience of over nine years.

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