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# Design for Manufacturing (DFM) is an Essential Enabler for Industry 4.0

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Industry 4.0 is the use of smart technologies to provide a step-change in productivity, efficiency, experience, and flexibility across the value chain of design, manufacturing, supply chain, and service. One area of loss of productivity and efficiency is the handover between two functions of design and manufacturing. Implementing design for manufacturing (DFM) by leveraging smart technologies can improve productivity and efficiency. This PoV discusses the need for DFM and highlights examples of a successful technology solution.

## DFM minimizes defects and rework

Design for manufacturing (DFM) is a methodology that involves designing with an intent to reduce the cost of production and time-to-market, without compromising on the quality of the product. DFM minimizes defects and rework and, in the process, saves costs and shortens time to market.

Many a times, design engineers are not familiar with all the manufacturing process requirements and downstream-related parameters. Decisions made by engineers during the design stage have cascading implications on product cost, quality, and time to market. As a result, engineering changes happen too late in the cycle when issues are detected during manufacturing or assembly—and it's costly to modify the designs.

Research indicates that around 70% of the product cost is committed during the design stage. An error detected and rectified during the design stage costs almost 100 times less than when rectified at the manufacturing stage. Sometimes, if the error gets passed into production, it can also have a direct impact in the form of costly product recalls and loss of confidence amongst customers and shareholders.

On a global average, 30% – 35% of engineering effort is spent on rework due to late design changes occurring because of downstream manufacturability and assembly issues. This rework can be avoided when DFM is followed as an integral part of the product development process.

## Organization-wide DFM needs technology solutions; current DFM practices are not scalable

To implement DFM, organizations need to understand the decisions that should be made by designers when the product is getting created. There are multiple design options that should be carefully evaluated not only with respect to form, fit, and function but also by looking at manufacturing feasibility and cost of each choice. There are three key areas of design that design engineers should be cautious about while evaluating options and making choices: material choices, the geometry of features, and tolerances.

The designer needs to get feedback on cost and manufacturability during the design stage on the three points mentioned previously. The feedback may involve design reviews by senior design engineers who are familiar with the manufacturing processes, or inputs from manufacturing engineers during the design stage. Many organizations incorporate DFM practices in a checklist, which is manually verified by designers before submitting the final design.

Although organizations are managing with design reviews by experienced engineers and checklists, this method has its limitations because of which organizations are not able to leverage at scale. Some of the limitations or hurdles are:

- **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 errors.
- **The 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 and 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 and cost. This requires referring to the active database of tools and processes. All these activities need to be repeated for every design. Any error during design validation early in the product creation cycle could cost a lot more problems during manufacturing.
- **Managing concurrent engineering teams across geographies becomes difficult.** DFM proponents advocate that concurrent engineering teams be created, which consist of engineers from various departments like design, manufacturing, and quality among others. However, managing such teams is not easy. Additionally, in the current global manufacturing scenario, such teams are likely to be widely dispersed. For similar parts, it makes sense to have an automated process in place.

Thus, manual DFM implementation methods are time-consuming, error-prone, and ambiguous. Wouldn't it be good if the design were checked for manufacturing suitability automatically?

## DFM compliance through software is the solution

The need of the hour is a simple, easy to use, yet powerful tool, which allows quick validation of designs for ease of manufacturing—automating the DFM reviews to a large extent. Considering manufacturing, can we assist the designer in taking the right decisions? Can we help him/her quickly self-review the design as per recommended organizational best practices?

By bringing automation to DFM implementation, process effectiveness will increase considerably as knowledge gets captured and reused appropriately, and location proximity and iterations of designs between engineering and manufacturing is minimized. 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 to reduce 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. A 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 eliminate losses in data translation. Additionally, the DFM review software can make use of the native CAD properties for DFM checks.

## Manufacturers across industries got DFM benefits from HCL's DFMPro® software

DFMPro® is a best-practice-driven CAD integrated DFM solution that enables engineering executives to make informed design decisions by identifying and addressing downstream manufacturability, assembly, serviceability, and quality-related issues during the early design stage. It facilitates the implementation of DFM methods and guidelines in a systematic manner and improves the design process.

HCL's DFMPro® solution works with all major CAD platforms and automates and formalizes the design review process. Seamless integration into the CAD environment allows users to work in a familiar environment and run DFM analysis during the early design stage. It evaluates CAD models for various DFM guidelines and suggests corrective actions based on its out-of-the-box library of 200+ design guidelines. DFMPro® provides a knowledge-driven framework to capture an organization's design best practices and industry standards in the form of DFM guidelines and enables designers to easily use these guidelines during the design stage. DFMPro® has been successful with many customers across different industries. Some examples are given below:

**Exhibit 1: How DFMPro® Helped Manufactures in DFM**

| Client | Challenges | Solution | Benefits |
|---|---|---|---|
| A world leader in R&D, design, and manufacturing of high-tech equipment | • Minimize equipment failure and breakdown during operations<br>• Improve order fulfillment time by reducing design rework and iterations<br>• Minimize part costs and reduce dependence on a few suppliers | • DFMPro® identified and addressed critical design issues that increased manufacturing costs, rework, and impacted part quality.<br>• Standard design guidelines were created in DFMPro® to address supplier lock-in issues and improve production ramp-up. | • The client achieved an estimated part cost savings of over USD 3 million in a year, by identifying and addressing inadequate design features that increased equipment downtime costs and manufacturing costs.<br>• Based on first time right approach, DFMPro® automated the design review process and increased the productivity of design engineers.<br>• Design standardization reduced dependency on single supplier and order fulfillment slippage. |

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|---|---|---|---|
| Leading Aerospace and Defense Manufacturer | • Reduce the cost of its program by 10%<br>• Reduce manufacturing complexity to reduce component costs<br>• Automate and streamline the design for the manufacturability review process | • DFMPro® analyzed and identified critical design issues that increased manufacturing complexity and cost.<br>• Automated and streamlined the process of performing manufacturing assessment of all components | • DFMPro® was beneficial in helping the client drive 10% savings in manufacturing costs.<br>• DFMPro® also identified direct savings in material costs and additional intangible overhead costs in rework and engineering changes. |

*Source: EIIRTrends, HCL, 2019*

## Bottom line: Manufacturers with Industry 4.0 aspirations can't afford the loss of productivity related to design defects and rework. They should move to predictable designs by implementing organization-wide DFM.

The next level of design productivity will come with technology solutions such as DFM. That will enable a step-change in the productivity needed for Industry 4.0. A DFM review automation tool moves the organization to predictable designs and saves considerable cost, time, and effort by improving productivity and reducing waste and rework. Implementing DFM is an easy fix which organizations should adopt and take another step in their Industry 4.0 journey.

## About the Author

### Pareekh Jain

Pareekh Jain is Founder and Lead Analyst of EIIRTrends and Pareekh Consulting.

EIIRTrends.com is a neutral platform to discover emerging engineering, IoT, Industry 4.0 and R&D (EIIR) trends across 12 industry verticals. Pareekh Consulting is a focused analyst and advisory firm for EIIR.

A seasoned EIIR professional, Pareekh has seen the EIIR industry from four perspectives: service provider, sourcing advisor, enterprise buyer, and industry analyst.

He is regularly quoted in the media on engineering services, IoT, and outsourcing trends, including Harvard Business Review (HBR), NDTV, Times of India, Economic Times, Business Standard, Hindu, Business Line, Livemint, Financial Express, Rediff, Voice of America, and Business Insider.

Pareekh is a thought leader, having authored various publications on topics related to EIIR outsourcing. He loves business fiction writing in his free time, and has authored a novel, Who Is That Lady?

Pareekh received his MBA from the Indian Institute of Management (IIM), Bangalore and his Bachelor of Technology degree from the Indian Institute of Technology (IIT) Delhi.

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