

Design with Confidence

CIMdata Commentary

Key takeaways:

- *Smooth product launches require early identification and resolution of manufacturing, assembly, serviceability, quality, and cost issues, well before production*
- *Design for eXcellence¹ is a strategy successfully used to ensure that products meet customer requirements such as manufacturing cost, quality, reliability, and serviceability*
- *Companies are using Geometric's DFMPRO solution to assess CAD models to identify DFX issues in the early design stage before any physical parts are produced, minimizing engineering change orders (ECOs) and rework, shortening the design to production cycle, and improving product quality*

Macro Trends in Manufacturing

The pressures on manufacturers are relentless. Customers expect innovative products at lower cost and higher quality. Competitors are racing to meet the same expectations, shareholders expect a reasonable return on investment, and regulations continue to get more stringent. In addition to these external pressures, companies also have to manage significant internal pressures. Much has been written about the poor state of public education, which leads to a lower level of skills on the manufacturing floor. Companies have more workforce turnover than in past years, making it harder to develop and transfer knowledge internally. Knowledge is also lost as the workforce ages and older employees retire. Finding ways to capture and effectively transfer knowledge will help keep manufacturing companies competitive.

Designing and producing products to meet the variety of pressures and requirements is daunting. The knowledge needed to meet these requirements is stored in many different repositories including handbooks, product and industry standards, consultants, service groups, and in employees' heads as tribal knowledge. Accessing this wide variety of information and applying it is an ad hoc process at best, and a disaster at worst.

Design and manufacturing reviews are typically used to catch issues before production. Ideally cross-functional teams of experienced people review the product design and manufacturing processes to ensure it will meet all the stakeholder expectations. Unfortunately unexpected issues such as, a material is not available, an undercut area on a part wasn't identified, a consumable item cannot be replaced without complete disassembly, don't get caught and make it to the prototype shop or production floor. In addition, subtle issues such as tolerances being too tight or stack-up errors can add cost by requiring more sophisticated manufacturing processes, or cause scrap because of production difficulties.

The Change Loop

A key goal in most companies is to maximize return on investment (ROI), or profits. Making changes later in the product lifecycle is understood to be more expensive and risky. Smooth product launches require early identification and resolution of issues. Engineering change

¹ http://www.ami.ac.uk/courses/topics/0248_dfx/

happens when the specification for a product or component is wrong and the documentation describing the product needs to be updated. There are many causes of changes ranging from simple mistakes to flawed concepts, to improvements from knowledge gained later in the product lifecycle. The graph on the left side of Figure 1 shows how costs due to changes typically vary over the product lifecycle. The graph on the right illustrates how investing more up front to get the design correct moves changes to an earlier point in the lifecycle where they are less expensive. To accomplish this shift is a never-ending task in most companies, and being able to leverage advanced design and manufacturing technology to ensure product designs are optimized before they get to production is a necessity.

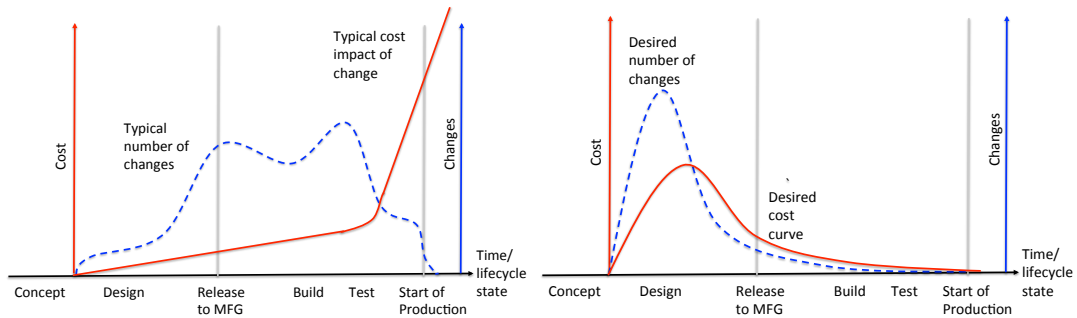


Figure 1—Impact on Cost of Change by Improving Design Process

When a product or component does not meet all its specifications, doing additional work can sometimes bring it into compliance with the specification and salvage it. This is commonly known as rework and always adds additional cost, but is usually better than scrapping the product or component. Rework and change, especially change that happens after the product is being physically produced is expensive and mostly avoidable. Well-documented processes, procedures, standards and guidelines help product developers get designs right the first time avoiding change and rework.

The cost of a product is established early in the product lifecycle, during the design phase before a physical representation is produced. The product's size, shape, functions, materials, and manufacturing processes are important elements that define and control the product cost. Modern software tools such as computer-aided design (CAD), computer-aided manufacturing (CAM), graphic design, spreadsheets, collaboration, and email are used to develop an electronic, virtual definition of the product at a relatively low cost. Minimizing total cost while meeting all product requirements involves consideration of many factors. This consideration in the design phase of product development is commonly known as Design for X (DFX) or Design for eXcellence. Figure 2 illustrates the areas that typically constrain a design. Each of these areas can consist of many elements. Some of the elements are well-known standards and industry best practices, but others can be proprietary and used to generate a competitive advantage. The key is to evaluate the product against all the appropriate constraints early in the lifecycle so changes can be incorporated early and at low cost.

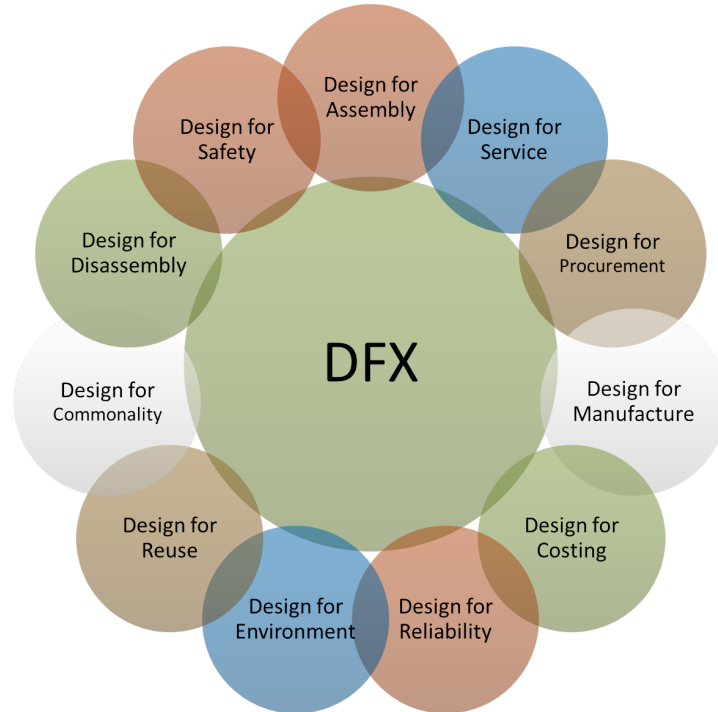


Figure 2—Common DFX Constraints
(Courtesy of Geometric)

Geometric's DFMPPro

Geometric provides software solutions spanning the product realization value chain to support manufacturing companies. The company provides software development services to most major CAD/CAM and PLM solution providers and also develops their own products focused on product realization, including DFMPPro and CAMWorks.

DFMPPro is an application that captures and reuses manufacturing best practices. The software consists of an extensible rules engine, and rules database supporting a wide variety of manufacturing processes including milling, drilling, turning, injection molding, die casting, sheet metal cutting & forming, as well as assembly, welding and tolerance checks. DFMPPro uses these manufacturing process-based rules to assess how well a process will work on geometry defined in a CAD model. These assessments identify issues while the product is still in its virtual state, reducing the cost of change. In future releases Geometric plans to support forging, deep draw sheet metal, additive manufacturing, metal injection molding, blow molding, composites, and tube/pipe bending among other processes.

DFMPPro comes preloaded with rules encoded from a variety of sources including handbooks, industry standards, standards governing bodies, proprietary Geometric knowledge, and customer feedback. Typical rules include draft and wall thickness for cast or molded parts, bend radii for sheet metal, and bolt thread engagement for assembled products. Custom rules can be added to support company-specific requirements. By automating the assessment process, DFMPPro runs checks consistently, and they can be run early and often so issues are addressed before they become problems, resulting in significant benefits for users. In addition, productivity is improved because mistakes due to lower skill levels are caught without human intervention.

DFMPro supports most major CAD formats including CATIA, Creo, Inventor, NX, SolidWorks, Solid Edge, as well as neutral formats like IGES, Parasolid, and STEP. It can be run as a standalone application or within supported CAD tools (Creo, NX, SolidWorks). Its operation is relatively simple: open a CAD model, select the process to be evaluated, and review the results. Rule violations are displayed on the model and described textually. Reports can be generated automatically for offline review. While there are geometry and CAD file checkers available in the market, they focus on CAD-related issues not manufacturing issues. In a sense, DFMPro functions as a spelling and grammar check for manufacturing processes.

CIMdata and Geometric reviewed several ROI examples in the automotive, aerospace, semiconductor equipment, and industrial equipment industries where Geometric customers estimated annual savings from using DFMPro. Areas where savings were measured included rework, tooling, warranty & scrap, design throughput, and collaboration. In the examples, reviewed companies had from 82 to 200 designers and the total annual savings ranged from US\$2.7 to US\$5.1 million, an impressive result.

Conclusion

Getting the design right at the beginning is key to meeting product cost, quality, and time to market objectives. Changes or rework due to manufacturing issues are expensive because of investments in time and/or materials and impacts being discovered after most of the investment has been made. If issues are caught early in the design cycle, changes can be more easily accommodated and taken care of when the cost of change is lower.

Historically design reviews were done manually, but Geometric's DFMPro enables many common issues to be identified automatically by the designer and remedied before the design review meetings even happen. DFMPro can evaluate models from most common CAD tools against many common manufacturing processes, to identify potential issues early in the product lifecycle, helping to resolve issues early avoiding expensive changes later in the lifecycle.

CIMdata believes that incorporating a DFX strategy within design organizations can help companies produce better, more profitable products. Automating DFX processes with a tool like Geometric's DFMPro should help to move changes to the design phase where they are less expensive to implement and require less rework.

About CIMdata

CIMdata, an independent worldwide firm, provides strategic management consulting to maximize an enterprise's ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM). CIMdata provides world-class knowledge, expertise, and best-practice methods on PLM. CIMdata also offers research, subscription services, publications, and education through international conferences. To learn more about CIMdata's services, visit our website at <http://www.CIMdata.com> or contact CIMdata at: 3909 Research Park Drive, Ann Arbor, MI 48108, USA. Tel: +1 734.668.9922. Fax: +1 734.668.1957; or at Oogststraat 20, 6004 CV Weert, The Netherlands. Tel: +31 (0) 495.533.666.