

# Proactive Design Simplification - Integrating DFMA in New Product Development

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## Abstract

DFMA forms the basis for a forward-looking process for defining new product designs with the perspective of Proactive Design Simplification. And as such, provides the opportunity to identify creative solutions that reduce design complexity and therefore reduce project work content – fewer items to design, source, assemble, etc. As an integrated process within New Product Development programs, DFMA provides design direction by defining the design, components, and processes which drive NPD activities. Early application of the DFMA process identifies solutions sooner, leading the design analytically through the early phases of product development then continues to improve and refine the design as the project progresses through later phases. Creating the perspective of Proactive Design Simplification in this manner maximizes the opportunity to realize the benefits of DFMA, providing the proactive, analytical mechanism for defining creative design solutions that lead to enhanced value, intrinsic quality, and profitability.

## Design Simplification in New Product Development

Our ability to influence the result of our product’s design (costs, complexity, manufacturability, assemblability) is highest during early product definition and concept stages while the product and its components are still being defined. As the product design progresses the ability to influence results diminishes rapidly. We become invested in a particular solution, build and test prototypes, and have

suppliers work on long lead items. Reacting to cost and manufacturability issues later in development becomes more difficult. Teams are reluctant to make significant design changes, preferring incremental changes with little perceived risk. Time has become short; product launch is near. However, that tends to be when it receives the most attention.



Figure 1. Ability To Influence

Analytically addressing the design elements that drive a product’s complexity, process, quality, and cost from the beginning of the product development cycle, maximizes the opportunity to achieve the best overall product. Following a

structured process that is integral to product creation and development provides the opportunity to identify creative solutions with reduced design complexity, process complexity, and total costs.

Proactive Design Simplification™ is an interactive, interdisciplinary, proactive approach to eliminating costly waste in a product by reducing the design complexity that drives complex processes, poor quality and excessive costs. DFMA forms the basis for this forward-looking process for defining new product

designs. Design simplification (a fundamental DFMA principle) applied proactively, provides design direction by defining the design, the components, and the processes which drive NPD activities.

Integral to Product Development, Proactive Design Simplification defines early concepts then continues to improve and refine the design progressing through product launch. Proactive Design Simplification maximizes the opportunity to realize the benefits of DFMA, providing the proactive, analytical mechanism for defining creative solutions that lead to enhanced value, intrinsic quality, and profitability.

## Design Influence

Design drives everything downstream! Seventy percent or more of a product's total cost is determined by the product's design! Design complexity drives the number of parts, the materials they're made from, which processes are used to produce or fabricate them, how the parts assemble and secure, production labor requirements, the tools & equipment needed, production process and line layout, quality levels, and of course, all their associated costs.

These elements drive the overall work content of the product development project. More parts mean more design resources are required to design, specify, and source them. There are more interfaces, joints, and fastening requirements along with tolerance analyses to ensure part consistency and fit. Not to mention functionality. Every part requires at least one process step, and usually multiple steps. This drives manufacturing complexity and resources for process design, verification & validation, quality inspections, and testing. Manufacturing and assembly equipment, fixtures, and tools are also required, many uniquely designed. And let's not forget documentation, from CAD models and part drawings to purchase orders, work instructions, and more. In short, increased complexity in product design results in increased complexity in process design, increasing resources and time required for both product & process development.

Essentially, product design determines the complexity of the product, its processes, quality, and total costs, and therefore, productivity and profitability.

Actively addressing the design's impact on manufacturability, quality, and cost early in the development process maximizes the opportunity to realize producible, high quality, and profitable products. Proactive Design Simplification actively identifies opportunities and defines solutions with lower complexity ensuring positive impacts on manufacturing, assembly, quality, and cost. This early, proactive approach to design simplification results in fewer design elements, thereby reducing project work content, resources, and time to market.

## Proactive Design Simplification

Proactive Design Simplification is a collaborative process for design simplification, quality improvement, and cost avoidance grounded in the principles of DFMA, Lean, and IPPD. As a forward-looking process for defining new product designs, DFMA forms the basis for a proactive, analytical mechanism to discover opportunities, define creative concepts, and develop innovative solutions. Unlike many organizations that utilize DFMA (or other less formal methods) as a "rear-view mirror" to evaluate and improve what they've designed, a proactive approach is looking to define what should be designed. The overall objective is to



*Figure 2. Design's Influence on Total Product Cost*

define product solutions that are easy to produce profitably integral with concept generation and design activities. Critical to DFMA success is the word “Design”.

*DESIGN* for Manufacture and Assembly

It’s not about how we’ll manufacture & assemble what we’ve designed,  
but how we’ll DESIGN so it can be manufactured and assembled.

It requires actively addressing how design complexity drives potential issues downstream and defining alternative solutions that eliminate them. DFMA analyses lead the design, highlighting opportunities and providing metrics for data-driven decision making. Understanding the impact design concepts present provides the team with the insights to define creative and innovative new solutions that are easier to produce with higher quality and lower costs. Simple, elegant, and smart designs require creative, innovative thinking by interdisciplinary development teams. They need to think differently to define creative solutions while working differently to define better designs. Quoting Albert Einstein:

*“We cannot solve our problems with the same thinking we used when we created them.”*

To proactively define simpler, innovative design solutions, it’s important to consider DFMA as a process. A process that the interdisciplinary team actively participates in and is integral to the organization’s product

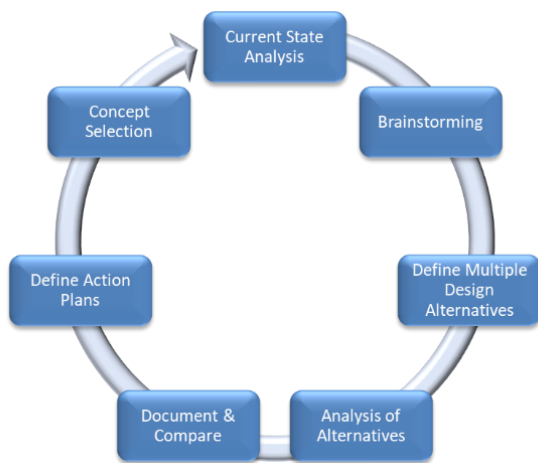


Figure 3. Proactive Design Simplification Process

development process – Proactive Design Simplification. More than just a design review, disconnected brainstorming session, or set of design guidelines, the process moves the team from analyzing and understanding the impact of the current state, through generating and defining multiple design alternatives, to understanding their benefits, with metrics and actionable steps for moving forward.

The team interactively generates and defines design concepts focusing on simplification principles and value-added components. Define fewer multifunctional parts, how they interface and secure, then select materials and optimize for selected processes. Allowing the team to discuss and create ideas, sketch

possibilities, and consider alternate materials, processes, and configurations yields significantly better results than random brainstorming events. Open interaction with creative, innovative thinking leads to more interesting solutions with significant benefits.

Team participation creates a sense of ownership, gains buy-in, and raises confidence to move forward with new concepts. Having defined the concepts, vetted them from an engineering perspective, and evaluated assemblability, manufacturability, quality, and cost, with metrics, concept selection will be informed, and data driven. The team shares a common vision, direction and goal for the project, focused on making the design work.

Designs don’t have to be detailed to conduct DFMA analyses. The proverbial “napkin sketch” of a product concept is enough to evaluate. The process interrogates assumptions to identify possibilities for areas that are undefined, leading the team to new ideas and consider alternatives to what they would normally do. Asking the questions of “what if ...” to find those new solutions. Analyzing at the sketch level requires the team to think about what they have not yet considered, triggering new ideas and encouraging possibilities.

This leads to multiple ideas that combine into multiple solutions providing the team with a range of design alternatives. The analyses result in metrics for each design concept, including cost estimates, used for comparison and decision making. One can think of these analyses as a form of analytical modeling of the design, where early concept analyses are coarse models with less detail, and later models as refined or detailed as the design becomes more detailed.

## Product Development Phases

Typical product development programs progress through several stages or phases from initial requirements through to production. Design reviews or phase gate reviews typically occur between phases to inform others, evaluate the design against requirements, identify potential issues and function as decision milestones for continuance. While the specifics and criterion of each phase may differ between companies and industries, they generally follow an overall track similar to the one shown below.

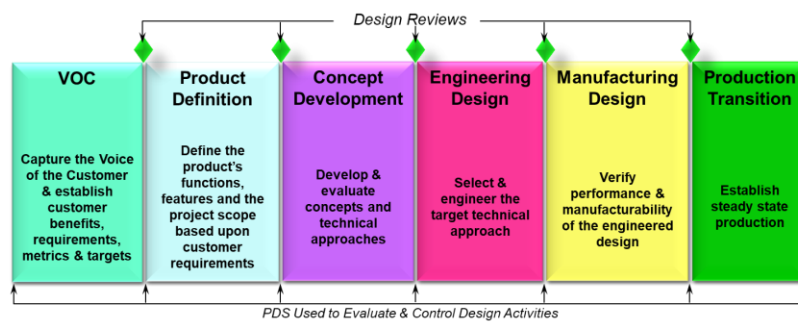


Figure 4. Product Development Phases

DFMA applies throughout all phases of NPD, shifting from a proactive, design focused approach in early development phases, to a responsive, problem-solving approach in later phases. As an integrated process within New Product Development programs, Proactive Design Simplification improves design direction with lower design complexity driving NPD activities. When fully integrated into the NPD process, Proactive Design Simplification forms the framework to define, evaluate & control design activities with improved communications and decision making, becoming the way in which new products are developed.

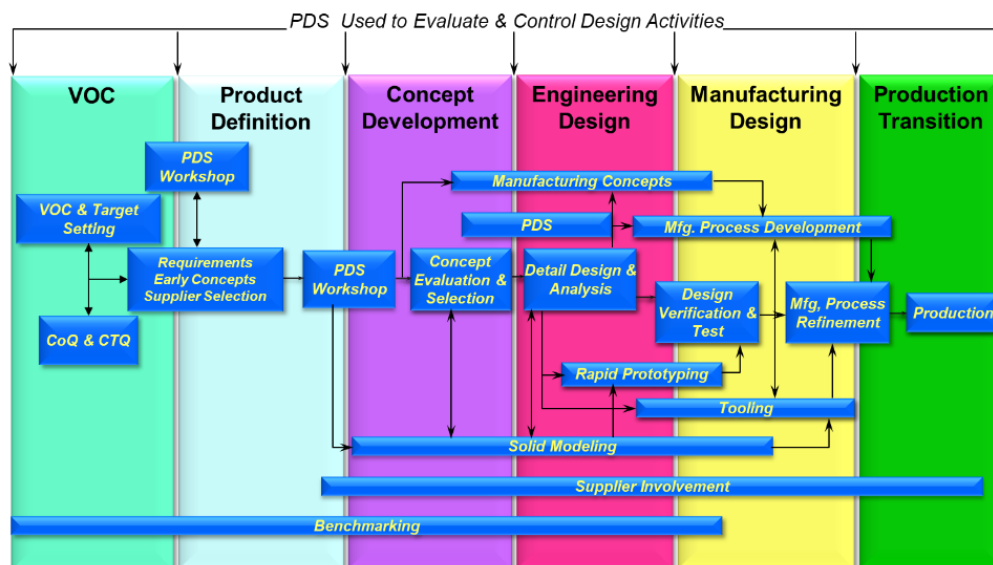


Figure 5. Product Development Process

# Product Development Process

The product development process chart illustrates activities typical of new product development projects. Within this process, focused DFMA sessions occur to define, develop, and evaluate multiple design alternatives and solutions leading to products that meet or exceed all requirements, targets, costs, and quality levels.

DFMA analyses performed throughout the project continue to provide the data and metrics that inform the team as well as management. Analyses lead the design direction as well as track status against targets and potential deviations. Included as part of all design reviews and decision criteria, DFMA analyses and metrics are a key element in management decisions and identifying corrective actions.

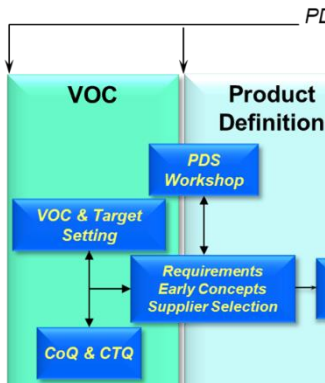


Figure 6. Early Development Phases

Very early in the development process design focus is on developing high-level concept alternatives for Voice of the Customer and Product Definition activities. High level systems view of the product and coarse models are produced of varied configurations, appearances, and other characteristics following the proactive DFMA process. The concepts and information generated feed into VOC and Requirements activities to gain feedback on concepts. This feedback helps refine requirements and improve understanding of customer benefits, needs & wants, including how the product may deliver them. While it's too soon for details and design specifics, these rough models provide more insight into what the product may be, how it could be produced, and a more informed sense of costs. This information feeds business cases for determining the potential for moving forward.

Through Competitive Benchmarking, organizations gain valuable insights into competitive products. Using DFMA analyses to conduct product teardown and benchmarking activities provides significant information regarding design, materials, how it's made, and costs. Competitive information that's valuable for understanding market conditions, VOC needs, and product definition.

## Concept Development Phase

Leading into the Concept Development phase, Proactive Design Simplification builds upon the information gained from the VOC & Definition phases to generate multiple design concepts with significantly more detail and information. A critical phase for Proactive Design Simplification / DFMA as this is when the team defines what should be designed. More than just directional alternatives, these concepts form the basis for the final product. System and subsystems are more defined along with component definitions for potential technologies, materials, & processes.

Awareness of potential manufacturing and assembly processes, difficulties, and opportunities increase as the team defines and models with additional design details. Refined part cost estimates are also produced within DFMA models, providing the team with BOM information and target alignment. Cost of quality metrics can be estimated through various predictive CoQ methods, giving additional insight to the product's overall producibility. The data, information, and metrics of cost, complexity, quality, profitability, etc. are the

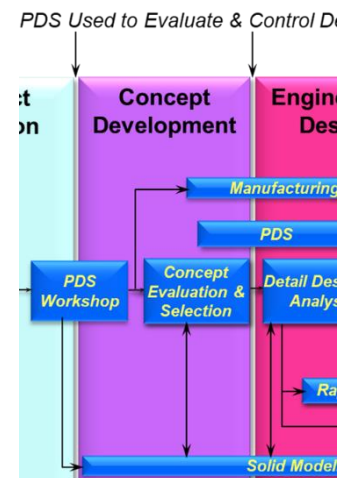


Figure 7. Concept Development

analytical results that describe each design alternative. Comparison of these metrics is a critical part of concept selection.

Developing and modeling these concepts following Proactive Design Simplification processes and DFMA principles with the cross-functional, interdisciplinary team ensures downstream concerns are addressed. Direct participation and involvement of all functional organizations lead to a common vision of the product and a common goal for the project.

## Engineering Design Phase

The Engineering Design Phase details the selected concept, parts, materials, and processes with the team focused on bringing their design to life. Continuing DFMA activities are more focused, and solution based on subsystems and components, identifying specific technologies, materials, & processes. Increased attention is paid toward part design characteristics as related to their specified materials, processes, and tolerances.

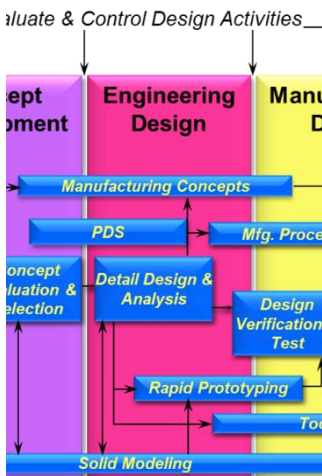


Figure 8. Engineering Design Phase

Modeling their impact on costs, quality, complexity and manufacturability keeps the team focused and on track against metrics and goals. DFMA methods and processes collaboratively find solutions as new issues arise preventing the tendency to add more parts late in the development process. A bit more problem solving and responsive than earlier phases, DFMA continues to improve and refine the design keeping complexity and costs in-check as the design matures.

DFMA is invaluable at each prototype cycle, not to evaluate the prototype, but to determine what to prototype. DFMA leads the design and therefore any prototypes. For each iteration, DFMA is the process to define the design changes necessary to prototype. With DFMA integrated into development processes, this becomes natural behavior because it is the process, not something extra to do.

Manufacturing and production processes evolve as an integral part of the Proactive Design Simplification process. Analyses inherently address manufacturability and production processes from the early first models and throughout product development. Each refinement of the product designs and their DFMA models also refine the manufacturing processes. Manufacturing concepts began to take shape during the Concept Phase, gaining detail and refinement during the Engineering Phase. Manufacturing Engineering utilizes these models and information for process development and planning, tool & equipment identification, personnel and space requirements. Gaining a head start on these activities in the early stages pays off as the process is being developed.

## Manufacturing & Production Phase

Continued use of DFMA throughout the Manufacturing and Production Phases ensures quality, cost and value are not compromised maintaining consistency against the goals, targets and metrics. Models are more focused, with significant detail on every part and process step. Process changes and different scenarios, as well as product design changes, can be modeled to evaluate their impact, improving decision making.

Production processes rely on numerous pieces of specialized equipment, fixtures, and tools that are often uniquely designed. Similarly to our products, they require design and development, and in some cases, significant design and development. Proactive Design Simplification applies to the design and development of production equipment, fixtures, and tools, providing the same benefits in reduced complexity, ease of build, cost, and maintainability.

As various issues arise, Proactive Design Simplification enhances problem solving by identifying and modeling solutions for both the product’s design and manufacturing processes. Resolving issues late in development is more difficult along with additional pressures to correct the issue quickly. Proactive Design Simplification brings the interdisciplinary team together to quickly find solutions to those issues. Often more focused and constrained regarding the scope of the problem-solving project, the process provides the most effective means to ensuring the right solution is implemented.

Once launched into steady state production, Proactive Design Simplification is invaluable for Continuous Improvement activities and other sustaining engineering activities. Product enhancements, variants, and modifications are well suited for Proactive Design Simplification to find and define their solutions.

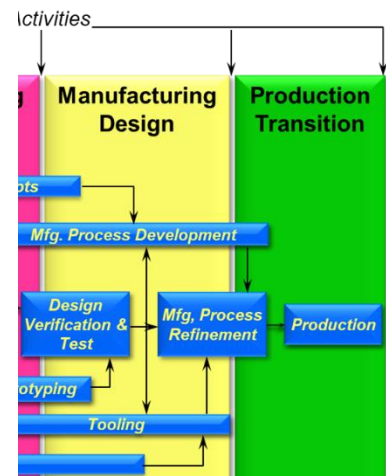


Figure 9. MFG. & Production Phase

## Summary

Proactive Design Simplification / DFMA is a process, and the power is in the process. Following the process yields significant results that benefit the product and the bottom line. If an organization decides to pick and choose certain elements or take a haphazard, discretionary approach, they’ll be underwhelmed and disappointed. Relying on guidelines, checklists and disconnected brainstorming sessions is not DFMA, let alone a process based on DFMA. On the other hand, if an organization fully integrates Proactive Design Simplification / DFMA into their New Product Development process, they’ll have better and more consistent results across all projects.

Integrated into New Product Development Processes, Proactive Design Simplification becomes the way products are developed versus special events or extra activities. Instead of being viewed as a distraction or “something else we have to do”, it becomes seamlessly integrated into the way products are developed. It employs the same personnel, the same discussions, the same decisions, just in a different form that improves those discussions and decisions, thereby improving the product’s design. Improved communications improve the development process and reduces overall time to market.

The analytics ensure the team understands the impact of their decisions and stays on target. The process allows the team to define and develop creative, innovative products, that are easier to produce and cost effective. Products with enhanced customer value, intrinsic quality, and profitability.

*“The greatest danger for most of us is not that our aim is too high, and we miss it, but that it is too low, and we reach it.” - Michelangelo*

**Proactive Design Simplification / DFMA**  
**The Power is in The Process®**