The Use of a Closed-Loop Dimensional Engineering Approach to Optimize DFMA

We constantly hear that we should take preventative actions today to protect our overall health, not just for the moment, but for later down the road as well. We get regular oil changes and tune-ups to maintain our cars. And we've all heard the phrase "pay me now or pay me later."

The value of planning ahead is no secret. We know we can save a lot of anguish and money by performing actions today that are designed to avoid problems later. This principle also applies to the quality of the products designed each day by engineers and is the driving force behind Design for Manufacturability and Assembly (DFMA).

The "healthiest," most successful engineering and manufacturing companies use tools early and often to address dimensional engineering problems before they occur. This prevents problems that others may not discover until manufacturing, assembly or – worse – until their end-customer experiences them as quality issues.

Ask the Right Questions – at the Right Time

In a DFMA environment, everything starts in design. Engineers *proactively* and *concurrently* design products with a consideration of all manufacturing aspects and functions including fabrication, assembly, testing and more. By asking the right questions early on in the design phase of a product or program, they can assure the best possible cost, quality, reliability, regulatory compliance, safety, time-to-market, and customer satisfaction.

Some of their key questions include:

- Is the quality process in control?
- Is it linked to our program objectives?
- Are our product and process requirements tightly defined and traceable?
- Are there any process considerations being made for dimensional objectives?
- Does our design strategy link to our manufacturing and assembly objectives – and vice versa?

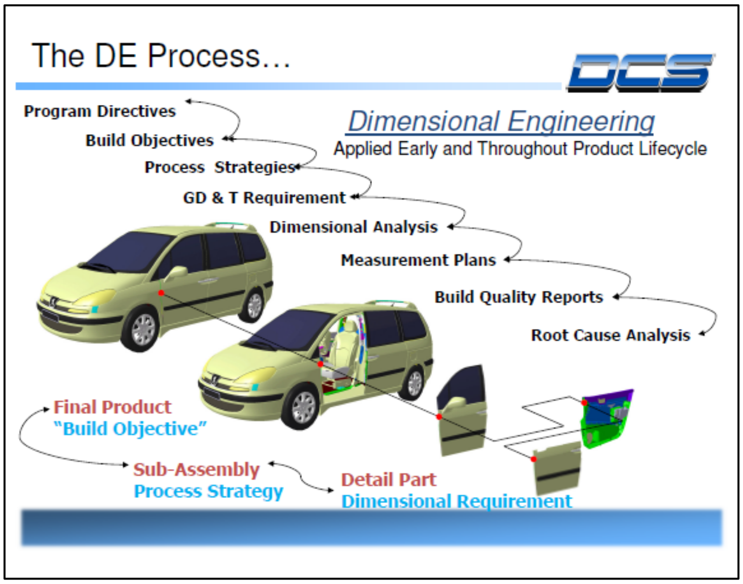
Dimensional Engineering Process Aligns With DFMA

In a healthy DFMA environment, team members from design, quality, manufacturing and assembly work together to optimize the design for cost-effective manufacturing.

If and when a DFMA team does not achieve this goal, it is often the result of a poor definition of requirements, an improper allocation of tolerances, or the lack of early specification validation. The case for a well-defined dimensional engineering process has never been greater.

Many leading manufacturing and engineering organizations use dimensional engineering software to drive variation analysis within a DFMA environment. The software provided by Dimensional Control Systems (DCS), for example, enables users to validate manufactured components, regardless of where or how they are manufactured. With the application of 3D data, sophisticated measurements, visual simulation and testing, engineers can quickly identify problems and perform root cause analyses to solve problems -- avoiding the need to chase problems through their manufacturing and assembly steps.

The dimensional engineering process looks like the image at right.



With DCS, engineers are empowered to analyze tolerance stack-ups and their effects on overall assembly.

They can address, with precision, the three key questions that drive the perceived quality of every product:

- Do things fit together as intended?
- Does the product look like it is supposed to look?
- Does the product function as intended?

To answer these questions, engineers view how assemblies fit together and then adjust tolerances and/or properties to better achieve their business goals. For example, they can use visual simulation to identify flush and gap misalignments, part interference, hole-winking and related issues.

There is no other way engineers could predict these problems, as they cannot be seen in standard CAD/CAM views. It's not easy to catch these problems until the manufacturing or assembly stages. If the problems are identified at this late stage, the costs involved in rework, scrap and corrective actions can become exorbitant.

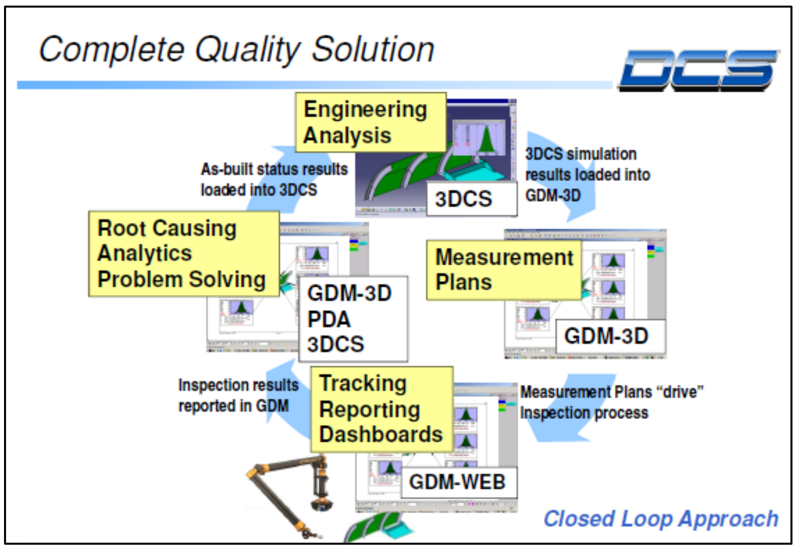
The majority of critical assembled components in nearly all complex, assembled products, large or small, being built today are subjected to 3D-model-based tolerance analysis. Engineers use these variation analysis tools to understand dimensional fit characteristics and quality status before they begin manufacturing or assembly. Variation analysis is also used in production monitoring and early-stage low-volume prototype development.

The use of tolerance analysis enables leading organizations to achieve robust and repeatable manufacturing and assembly processes for their products. This results in shorter launch cycles, improved process capabilities, reduced scrap and less production downtime.

"Closed-Loop" System is Integral to True DFMA

A comprehensive dimensional engineering process enables fit, finish, and function to be analyzed. Multiple solutions can be tried through visual simulation then validated through automated as-built reporting. This "closed-loop" system drives product quality all the way from design engineering to production. By definition, it is integral to DFMA.

A closed-loop dimensional engineering system, such as the one enabled by DCS tools, looks like the image at the right.



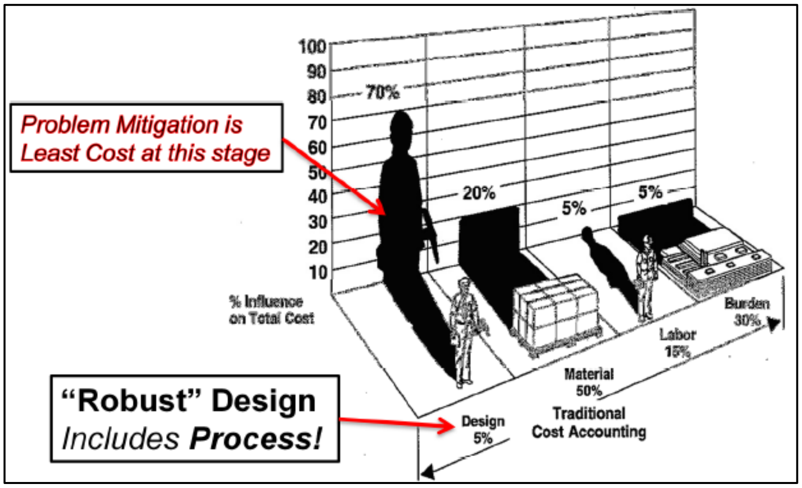
A "closed-loop" Quality Management system enables engineers to correlate the theoretical tolerance analysis results produced during simulation to the actual as-built results determined at other stages of the quality process. Based on correlations, the as-designed simulation parameters can be validated, or the as-designed simulation parameters can be adjusted to more closely align to production process capabilities.

Robustness, DFMA and the Closed-Loop Approach

Timing is a critical element to design robustness and a core element of a healthy, effective DFMA approach. A closed-loop dimensional engineering process optimizes timing, allowing users to apply simulation and analysis to evaluate design and assembly strategies *up front*, where problems and alternatives can be identified early on.

Using visual simulation early on in a closed-loop dimensional engineering process is an effective way to ensure that specifications are "virtually" validated and future problems in manufacturing and assembly are minimized.

It has been shown that nearly 70 percent of a product's lifecycle costs occur in the earliest stages of the development cycle.



At this stage, the downstream impact areas are all affected by the specifications set during initial design.

"Runaway costs," scrapped parts and rework often result when specifications are not validated until after manufacturing is well underway.

The Gift that Keeps On Giving

A closed-loop dimensional engineering system enables best practices to be validated, captured and reused on future programs for both engineering simulation and manufacturing – benefits that align with a true DFMA approach.

Leading engineering and manufacturing organizations are adopting closed-loop systems more and more frequently to improve their program efficiency – a necessity as they face ever-tightening development cycles and budgets. The intelligence they gather through such systems helps them discover ways to reuse existing and proven manufacturing process elements and modularized tooling on new and re-design programs – saving time and cost.

About Dimensional Control Systems

Dimensional Control Systems Inc. (DCS) is a world-class experienced provider of quality management software solutions and consulting services. Established in 1994, DCS is a privately held company with partners and customers around the world. Leading organizations like Chrysler, General Motors, BMW, Daimler AG, Volkswagen, Airbus, Boeing, Embraer, Herman Miller, IBM, Lockheed Martin, and many major tier-one and tier-two suppliers use DCS solutions to optimize product design and manufacturing processes, improve quality, and reduce program cost and timing. DCS' 3D tolerance analysis and quality assurance software applications fully support the entire product quality lifecycle.

For more information, see www.3dcs.com.