Design for Manufacturing & Assembly

Best Practices

Global Executive Solutions

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Defining the parameters of Design for Manufacturing and Assembly (DFMA)

Beginning with fundamental cost drivers and ending with checklists of cost and risk reduction recommendations, DFMA provides a practical toolset of approaches used in creating the most efficient/effective manufacturing and assembly processes. Encompassed in this approach are considerations incorporated into the design and development activities associated with the product lifecycle, including reliability, testability, maintenance/service, ergonomics, safety and environment to name a few characteristics. Generally, these parameters are all included in the design to look at the product from cradle to grave and ensures that all stakeholders in the product, from designer and factory workers to end users, will have their needs addressed. When DFMA is implemented in a systematic manner there are benefits to speed to market with successful roll-out, lower production costs through increased automation as well as a reduction of design complexity.

Product and process must be co-developed to achieve high manufacturing yields with minimum rework or rejections. Process capabilities must be matched to the product design tolerances in order to achieve:

- Reduction in process related manufacturing defects
- Improved long term product reliability
- Virtual elimination of rework/repair
- Reduction in Unit Production Cost
- Enhanced effectiveness of Statistical Process Control
- Increased focus on “sensitive” design elements
- Decreased need for engineering/process changes

To achieve these conditions, concurrent engineering disciplines are a necessity in the design process. Through this approach, multiple design options are considered during each major phase of the design project. Delaying decisions as long as possible will allow for maximum innovation and inputs into the design criteria, thereby allowing for change iterations to be managed and controlled through staged freezing of critical design elements. Balancing this approach with the inevitable pressure on schedule and cost must be a consideration as designs are developed. Noting that about 75% of product cost is determined in the engineering phase, a robust DFMA process will provide the best opportunity to drive cost as low as possible while creating an effective production process that supports customer needs.

Implementing DFMA may require the culture of the organization to shift to support the teamwork that using a concurrent engineering process with multiple groups having input in the design phase. In traditional organizations with a departmental structure, engineering typically has full control of new design. Introducing DFMA will require early integration of input from many other functional areas. This will require engineering team members developing skills to lead integrated product design teams that bring all the stakeholder’s input into the design process to drive success.

Assess Current Practices and Optimize

In many operations the DFMA process has been adapted to the capabilities of the facilities, its people and its operations. In order to obtain an understanding of the maturity level of current DFMA practices, it is necessary to define current DFMA methods being utilized within on-going manufacturing operations. To do so, it is essential to assess key elements of the current production process such as:

- Manufacturing processes linked to key product acceptance criteria
- Testing and process variability parameters
- Item Lot QA acceptance – key characteristic identification linked to final acceptance of products should also be assessed for Statistical Process Control applications and the potential for acceptance via SPC versus end item dimensional compliance to meeting certain performance parameters.

To optimize the DFMA approach, consideration should be given to defining current gaps centered on a goal of defining key manufacturing parameters related to end product testing performance criteria, acceptance parameters, and key producibility elements. How do we launch a new product with the confidence it will meet all established Technical Data Package dimensional and testing criteria with minimal financial risks to the program and customer. A good first step is conducting interviews with the Operations leadership, the Design Leads and key support personnel to capture their input to define and understand their approach to conducting the DFMA processes.

Best Practices Review

It should not be a surprise that "Best Practices" for DFMA is not a one process fits all scenario. Funding limitations and time constraints will always undermine the purists' scientific DFMA process. However, with acknowledging these conditions, there are still a variety of key criteria that must be performed to maximize the cost effectiveness of manufacturing and assembly processes, which directly tie to the lot acceptance testing of end item systems. Finding the funding sources or requiring the customers to accept the minimum critical path DFMA criteria within the program or business scope and schedule is imperative. It will enable a minimizing of failures in production and maximizing the ability for a system solution to be achieved in a final state. Without this a significant risk exists to going into production with an immature system, requiring design completion while in the production phase of a program.

The following key elements of DFMA are critical to having production ready, low risk, high performance solutions:

- Formal DFMA Policy/Procedures that complement the design and development process.
- Producibility/Manufacturing Engineering, upfront, in the design approach integrating concurrent engineering disciplines into the early stages of product/system design and development.
- Trade-off studies to determine the best materials and processes to be used to achieve objectives.
- Use of Stereo lithography or 3-D printing techniques to physically create simulated designs to determine physical form, fit and function and assess complexity of design to help determine areas needing simpler solutions to aid manufacturing and assembly.

- Reliability assessments, including stress testing and tolerance boundary testing (environmental and physical) to determine allowable variation of chosen materials and processes which in turn establish the true allowable
    - Transportation effects on the design reliability must also be assessed.
- Design to unit production cost analysis and trade-offs that include manual process, semi-manual process or fully automated production processes.
    - Use of manufacturing simulation and modeling together with lean manufacturing principles to determine these various DTUPC effects would allow for different HPU analyses to be conducted without having to physically build production lines
- The human effects on the production process should be minimized to eliminate body FOD, dependency on visual assessments and judgment calls for acceptability. Where humans are required, their decision making or physical interaction with the systems being manufactured and assembled need to be tightly controlled to reduce variation impacts to production.
    - Ergonomic impacts and job hazards analysis for proper safety protection equipment and the use/interaction with the product/system being produced.
- Critical to Quality Factors needs to be assessed to determine the Key characteristics for performance and Safety characteristics.
- Process FMEAs and System FMEAs are critical to assessing risks and developing mitigation against risks.
- Considerations for Electronic Obsolescence and counterfeiting controls need to be incorporated into the DFMA process.

Summary

Typically, all businesses are working with some elements of DFMA in their design and development programs. Each will suffer with the realities of customers deferring the execution of a thorough DFMA process during these design and development programs due to financial and/or schedule limitations, resulting in having the design and development effort completed during various aspects of the follow-on production programs. A gap analysis should be conducted using elements of the information provided within this paper for establishing an overarching DFMA policy from which companies can tailor specific procedures to address and incorporate DFMA practices into the design and development of their products and systems. Organizing the individual Operations' activities to incorporate these DFMA criteria into their design and development activities will go a long way to assuring the products and systems created by a company will result in low cost solutions with much lower levels of manufacturing and assembly risks as they move into the volume production phase of their programs to meet customer requirements.

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