Design for Manufacturing & Assembly (DFMA)

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28 Apr 05

Introduction

- In state-of-the-art weapon system development, emphasis is largely placed on designing to meet technical performance
- However, the manufacturing processes and cost associated with the design must also be addressed for overall program success
- Limited resources within DoD make designing for cost effectiveness even more imperative
- Numerous studies show that the most effective time to implement cost saving changes is early in the product design cycle
- Widely accepted commercial Systems Engineering standards consider “Manufacturing Processes” as one of the basic building blocks of a system
- The “Brick Wall” syndrome still exists today

DFMA Workshops are an excellent tool to break down the “Brick Wall”

What is DFMA?

- DFMA is a proactive and concurrent design process that allows for early consideration of manufacturing aspects

- The purpose is to generate an environment where a cross-functional team works together to optimize the design for cost effective manufacturing

Benefits

Tangible

- Shortened Development Time
- Reduced Development Costs
- Enhances a smooth transition to production
- Reduced parts count
- Simplified assembly processes
- Improved Quality (fewer opportunities for mistakes)
- Reduced manufacturing costs (thereby reducing AUPC and Life Cycle costs)

Intangible

- Improved communication within entire design team
- Promotes teamwork
- Increases Organizational ownership

DFMA Principles

1. Minimize the number of parts
2. Minimize the number of fasteners
3. Standardize
4. Avoid difficult components
5. Use modular subassemblies
6. Use multifunctional parts
7. Minimize reorientation
8. Use self-locating features
9. Avoid special tooling/test equipment
10. Provide accessibility
11. Minimize operations & process steps

Reduce, Eliminate, Combine, Minimize, Standardize, Productionize …

When to Implement

- Could conceivably conduct workshops during Concept phase
  - Focus on broad, wholesale design changes
  - Opportunity to consider manufacturing impacts of one technology vs. another
  - Be careful not to fine tune this design (could become obsolete)

- Most effective time is during Development Phase (prior to PDR)
  - Coincides with the time period where trade study activity is most active
  - Engineering testing will occur after PDR, which will prove-out changes
  - Technology has been selected, but design is flexible
  - Time remains in development schedule to incorporate significant cost saving changes

- Workshops during Development Phase after the PDR, but prior to the CDR
  - Design is becoming more fixed, but opportunities for cost savings still exist
  - Focus on fine tuning aspects of the design that successfully completed the PDR
  - Be careful not to implement major changes (no time to incorporate)

Key Points / Lessons Learned

- Must have multi-functional team
  - Concurrent Engineering
  - Include disciplines such as systems engineering, design, manufacturing, quality, test, etc (even manufacturing floor personnel)
- Use an independent facilitator
  - No ownership in design and can keep flow of workshop moving
- Conduct multiple workshops
  - break system down into manageable pieces
- Prep work
  - Overview description of hardware
  - Preliminary manufacturing assembly flows
  - Have some type of cost baseline to perform trade studies
- Utilize Brainstorming techniques
  - Facilitize free flow of ideas (check rank at the door)
  - Don’t be resistant to changes
  - Don’t get bogged down by trying to solve the details
- Follow-up on ideas after workshop has ended

DFMA Workshop Procedure

During the Workshop

(Normally scheduled for 1-2 days)

- Training
  - Educate team on workshop procedures and DFMA principles
  - Get people thinking in terms of producibility
- Baseline the current design
  - Team needs to understand where we are
  - Provide an overview description of hardware & assembly procedures
- Brainstorming Session
  - This is where the true benefit of the DFMA workshop is realized
  - Utilize Brainstorming techniques
- Categorize Ideas
  - What is risk to implement (technical & manufacturing)
  - Cost savings potential (Rough estimate - large, small, or insignificant)
  - Is there a cost to implement (development dollars, tooling, test equipment, etc)

DFMA Workshop Procedure

(Continued)

After the Workshop

- Detailed assessments and Implementation
  - Cull out brainstorming ideas that are too difficult, risky, or costly to implement
  - Focus on ideas that can truly benefit program
  - Incorporate results into Systems Engineering process
  - Perform detailed evaluations and/or trade studies
  - Identify candidates that can be implemented in current program
  - Identify candidates that can be implemented in other vehicles (Mantech, IRAD, Technology Insertion, etc)
- Quantify results
  - Document ideas that are carried forward
  - Document specific improvements
  - Identify cost savings (may be difficult in early development phases)

Examples

Program	Contractor	Results
Longbow (Transceiver CRP)	Lockheed Martin / BAE - Nashua	- Number of operations reduced 20% - Assembly hrs/unit reduced 20% - Floor space reduced 20% - Increased production from 52 to 220 units/mo
Longbow (Counteractive Protection System)	Remec / BDI	- Re-layout of electronics for accessibility - Number of chips & carriers reduced - Implemented auto assembly procedures - Combined parts
APKWS (Guidance Section)	BAE - Nashua / BDI	- Eliminated inaccessible areas - Color coded parts (assembly aide) - Injection moldings vs. machined parts - Eliminated fasteners and screws - Combined parts - Implemented self-alignment features
NLOS-LS (Seeker)	Raytheon - Tucson	- Generated 63 separate candidates - Reduction of alignment steps - Semi auto alignment procedures - Yield improvements for subcomponents - Candidates still being evaluated

Summary

- Successful implementation of DFMA principles results in reduced costs
- DFMA workshops serve as a practical tool to incorporate Concurrent Engineering procedures
- DFMA is a proven design methodology that works for Government and Commercial Industry

The AMRDEC Production Engineering Division's objective is to incorporate DFMA workshop requirements in all Development Program Scopes of Work

References

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