Do You Know Your Risks?

In your systems engineering process what knowledge do you have about Manufacturing Maturity?

Technology Readiness Levels

- Pre-Concept
  - TRL 1
  - TRL 2
  - TRL 3
- Material Solution Analysis
  - TRL 4
- Technology Development
  - Component
  - System
  - TRL 5
  - TRL 6
  - TRL 7
- Engineering and Manufacturing Development and Demonstration
  - TRL 8
  - TRL 9

Manufacturing Readiness Levels

- Pre-Concept
  - MRL 1
  - MRL 2
  - MRL 3
- Material
  - MRL 4
- Solution
  - MRL 5
- Analysis
  - MRL 6
- Technology
  - MRL 7
- Development
  - MRL 8
- Engineering
  - MRL 9
- and
  - MRL 10
- Manufacturing
- Readiness
- Levels

Systems Engineering Technical Reviews

- ITR
- ASR
- SRR
- PDR
- CDR
- PRR
- PCA

Operations and Support

- FRP Decision
Why use MRLs?

• Acquisition performance perceived as broken by users, Congress, and GAO
  – Numerous cost and schedule overruns
  – Not adequately addressing manufacturing issues early in the process is one of the key issues
• Addressing manufacturing earlier in the design/development process is being demanded
  – DoDI 5000.02
  – Congress (HR 6523 Section 812)
• Current performance in acquisition must be improved – MRLs just one tool to help
MRLs Recognized by Many

- NDIA Manufacturing Division endorses MRLs
- DoD ManTech Strategic Plan, March 2009
  - Thrust 3.1: Effective policies and practices to assess and improve manufacturing readiness
- DoDI 5000.02, Dec 2009
  - Moved manufacturing considerations to the left
  - Exit criteria based upon MRL definitions now required for all phases of acquisition
- GAO report 10-439, April 2010
  - In-depth assessment of MRL practices
  - Recommends requiring use of MRLs in DoD acquisition
- Congressional direction, Dec 2010
  - Requires MRLs on MDAPs
FY11 NDAA: SEC. 812. MANAGEMENT OF MANUFACTURING RISK IN MAJOR DEFENSE ACQUISITION PROGRAMS

Guidance Required- the Secretary of Defense shall issue comprehensive guidance on the management of manufacturing risk in major defense acquisition programs

The guidance issued under subsection (a) shall, at a minimum—

(1) require the use of manufacturing readiness levels as a basis for measuring, assessing, reporting, and communicating manufacturing readiness

(2) provide guidance on the definition of manufacturing readiness levels and how manufacturing readiness levels should be used to assess manufacturing risk and readiness

(3) specify manufacturing readiness levels that should be achieved at key milestones and decision points for major defense acquisition programs

(4) identify tools and models that may be used to assess, manage, and reduce risks that are identified in the course of manufacturing readiness assessments

(5) require appropriate consideration of the manufacturing readiness and manufacturing readiness processes of potential contractors and subcontractors as a part of the source selection process
MRL Process Defined in a Deskbook

Process well-defined – MRL Deskbook @ http://www.dodmrl.com

Deskbook has 6 chapters:

1. Introduction
2. Manufacturing Readiness Levels
3. MRLs and the Acquisition Management System
4. The Process for Conducting Assessments of Manufacturing Readiness
5. Manufacturing Maturation Plans and Risk Management
6. Applying MRLs in Contract Language
MRLs designed to identify and manage manufacturing risk.

The key is the MRL Matrix – the maturity levels are defined by expected criteria at each step along the development/design process.

- Define current level of manufacturing maturity
- Identify maturity shortfalls and associated costs and risks
- Provide the basis for manufacturing maturation and risk management
MRL Criteria – the Threads

**Technology and the Industrial Base:** Do you have the capability and capacity to produce?

**Design:** Is the design stable, mature and producible?

**Cost and Funding:** Is the cost realistic, affordable and is the funding in place for the system and for investments in maturing technologies and processes?

**Materials:** Are the materials available at all levels of the supply chain?

**Process Capability and Control:** Are your manufacturing processes proven, stable, capable and in control?

**Quality Management:** Is your QA program in place and effective throughout the supply chain?

**Manufacturing Workforce:** Is your manufacturing workforce trained and certified?

**Facilities:** Are your facilities in place, proven and capable throughout the supply chain?

**Manufacturing Management:** Is your manufacturing planning complete and ready for production?
The MRL Matrix is an expansion of the “Definitions and Descriptions”

- Includes nine major threads and twenty sub-threads
- Evaluation criteria for each thread
- Plotted against every acquisition phase and milestone decision point

<table>
<thead>
<tr>
<th>Acquisition Phase</th>
<th>MSA</th>
<th>Tech.</th>
<th>Dev.</th>
<th>Engr &amp; Mfg Dev.</th>
<th>LRIP</th>
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- **MRL 1** indicates the lowest level of technical maturity.
- **MRL 10** indicates the highest level of technical maturity. 
- Each level represents a different stage in the development and production readiness of a technology or system.
MRL Guidance

MRLs are an information tool for managers and engineers to identify, manage and mitigate manufacturing risk throughout the systems engineering process

- A common language used to assess manufacturing maturity
- Provide insight, not oversight

MRLs are not pass/fail – they identify risks!

- MRL 7 might not be good
- MRL 3 might not be bad
MRL Benefits

- Well-documented roadmap to achieve manufacturing maturity effectively and efficiently
  - Developed by Industry and Government manufacturing and systems engineering SMEs
- A tool that provides/requires fact-based information on a program’s manufacturing maturity
  - Essential for risk management
- A forcing function to get manufacturing considerations addressed earlier in the design & development process
- Provides process for managing & communicating manufacturing maturity across the supply chain and customer base
- Excellent tool to identify systemic manufacturing problems across programs/contractors/industrial base
Implementation Status

• MRL Deskbook at http://www.dodmrl.com
• Training available
  — AFIT course (SYS 213)
  — Some DAU courses
• Is a “Standard Operating Procedure” at many prime contractors
  — Raytheon, Honeywell, GE, Lockheed, etc
• DoD implementation mixed
  — OSD: DAG Chapter 4 provides manufacturing assessment criteria
  — Air Force: Firm guidance to use MRLs at SAF, AFMC, AFRL, ASC, and AAC
  — Army: Firm guidance on ManTech programs and significant use in acquisition
  — Navy: Used on some acquisition programs (NAVAIR is implementing MRLs)
  — MDA: Mixed use of EMRLs and MRLs
• Other Government agencies that have used or are using MRLs
  — DCMA, DOE, DOC, NASA, DHS
MRLs Integrated

MRLs have been integrated into the Acquisition process and the Systems Engineering process

- MRL criteria has been incorporated into DAG language for Design Reviews
- Language consistent with DoDI 5000.02 requirements
- MRL criteria are used in Program Support Reviews (PSRs)
How We Got Here – A Timeline

1999
Army (ASAALT) establishes Senior Panel to formulate MRLs

2000
DDR&E socializes MRLs with Defense, Industry and Academia

2001
DUSD (AS&C) request JDMTP to refine and institutionalize MRLs

2002
MRLs Version 3.0 and MRA process developed

2003

2004

2005

2006

2007

2008

2009

2010

2011

DOD 5000.02 includes MRL language

Congressional direction for MRLs in NDAA section 812

GAO report recommending MRLs is published

An overnight success – 11 years in the making!
Summary

- MRLs developed by SMEs from Industry, Government and Academia – continuously refined and improved by
  - Numerous joint workshops and pilot studies
- Process well defined – MRL Deskbook (http://www.dodmrl.com)
- Recognized process by manufacturing and systems engineering SMEs to reduce risk
  - Industry, Services, GAO, Congress & other Government agencies
- Integrated into Acquisition and Systems Engineering Process

MRLs are a tool that can reduce manufacturing risk!
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