Integrity ★ Service ★ Excellence

Manufacturing Readiness Assessment Overview

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Overview

- What is a Manufacturing Readiness Assessment (MRA)?
- Why Manufacturing Readiness?
- What are Manufacturing Readiness Levels (MRLs) and how do they pertain to the Acquisition Life Cycle?
- How to do an MRA
- Sample Outputs and Deliverables
- Finding and Conclusions
- Additional Information

What Is A Manufacturing Readiness Assessment?

- **An MRA is**
  - **An assessment of a program's readiness to manufacture and produce its intended design**
  - **A tool to develop and implement:**
    - **Manufacturing Maturating Plans (MMPs)**
    - **Business Strategies**
      - **Effects of Design Changes (Planned Upgrades, Spiral)**
      - **Pricing Agreements (Long Term vs. Single Lot)**
      - **Capital Investment Plans (Contractor and/or Government)**
- **An MRA**
  - **<u>Assigns Manufacturing Readiness Levels (MRLs)</u> to key system components**
  - **Analogous to Technology Readiness Levels (TRLs)**

Why Manufacturing Readiness?

Manufacturing & Industrial Base Challenge

- **Consensus among Congress, OSD, CSAF, GAO:**
  - ***"Advanced weapon systems cost too much, take too long to field, and are too expensive to sustain"***
- **GAO study of 54 weapons programs:**
  - **Core set of 26 programs: RDT&E costs up by 42% ($42.7B total) and schedule slipped by 20% (2.5 years on average)**
  - **Characteristics of successful programs (GAO):**
    - ***Mature technologies, stable designs, production processes in control***
    - ***S&T organization responsible for maturing technologies, rather than program or product development manager***
- **Products made by immature manufacturing processes generally:**
  - **Cost more**
  - **Are prone to quality problems**
  - **Experience schedule delays**
  - **May not perform the same**
  - **Are less reliable in service**

Technology Readiness Levels (TRLs)

Provide a common language and widely-understood standard for:

- **Assessing the *performance maturity* of a technology and plans for its future maturation**
- **Understanding the level of *performance risk* in trying to transition the technology into a weapon system application**

***TRLs leave major transition questions unanswered*:**

- **Is the technology producible?**
- **What will these cost in production?**
- **Can these be made in a production environment?**
- **Are key materials and components available?**

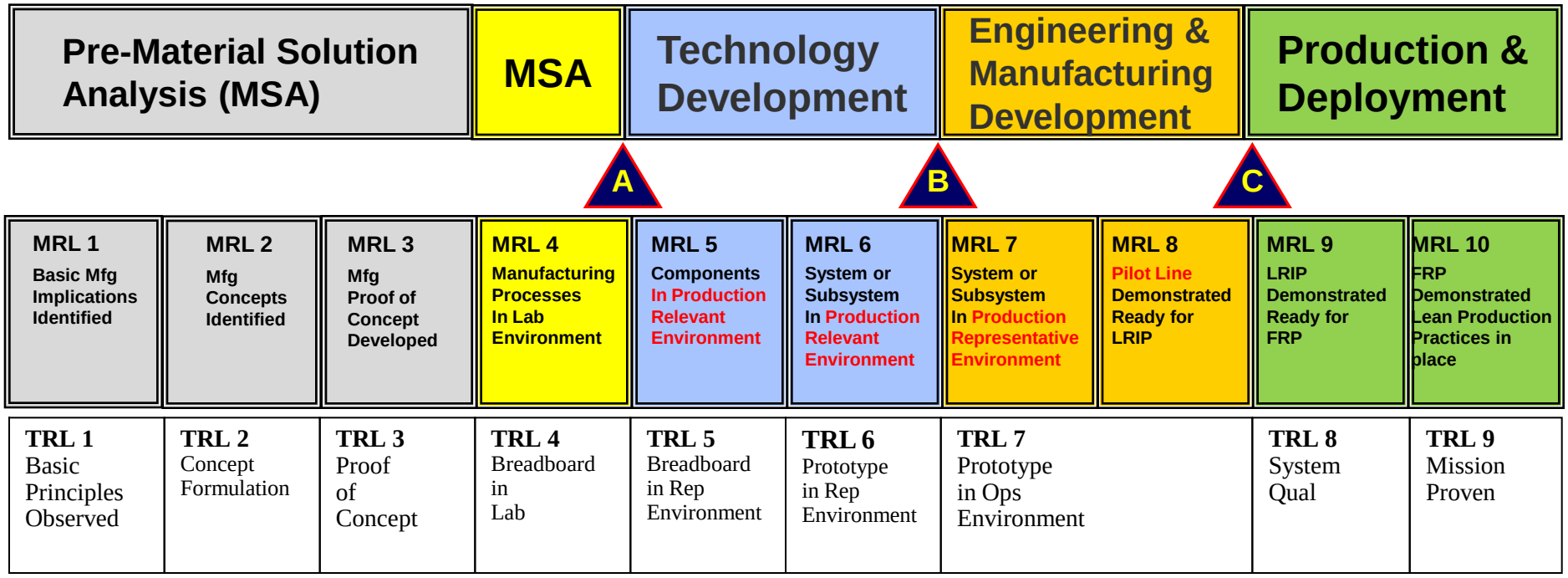
What are MRLs?

- **Common language and standard for**
  - **Assessing the *manufacturing maturity* of a technology or product and plans for its future maturation**
  - **Understanding the level of *manufacturing risk* in trying to produce a weapon system or transition technology into a weapon system application**
- **Designed to complement TRLs**
- **Designed to help set the agenda for manufacturing risk mitigation**
- **Establish an expectation of achieving manufacturing maturity at critical decision points**

NOTE: FY04 - Joint Defense Manufacturing Technology Panel (JDMTP) formed MRL Working Group to develop basic MRL definitions and criteria

MRL Relationships

Relationship to System Acquisition Milestones



Relationship to Technology Readiness Levels

MRL Evaluation Criteria
(Threads)

- **Nine "Threads" were developed to help assess the current MRL**
  - **A - Technology and Industrial Base**
  - **B - Design**
  - **C - Cost and Funding**
  - **D - Materials**
  - **E - Process Capability and Control**
  - **F - Quality Management**
  - **G - Manufacturing Workforce**
  - **H - Facilities**
  - **I - Manufacturing Management**

MRL Assessment Process (MRA)

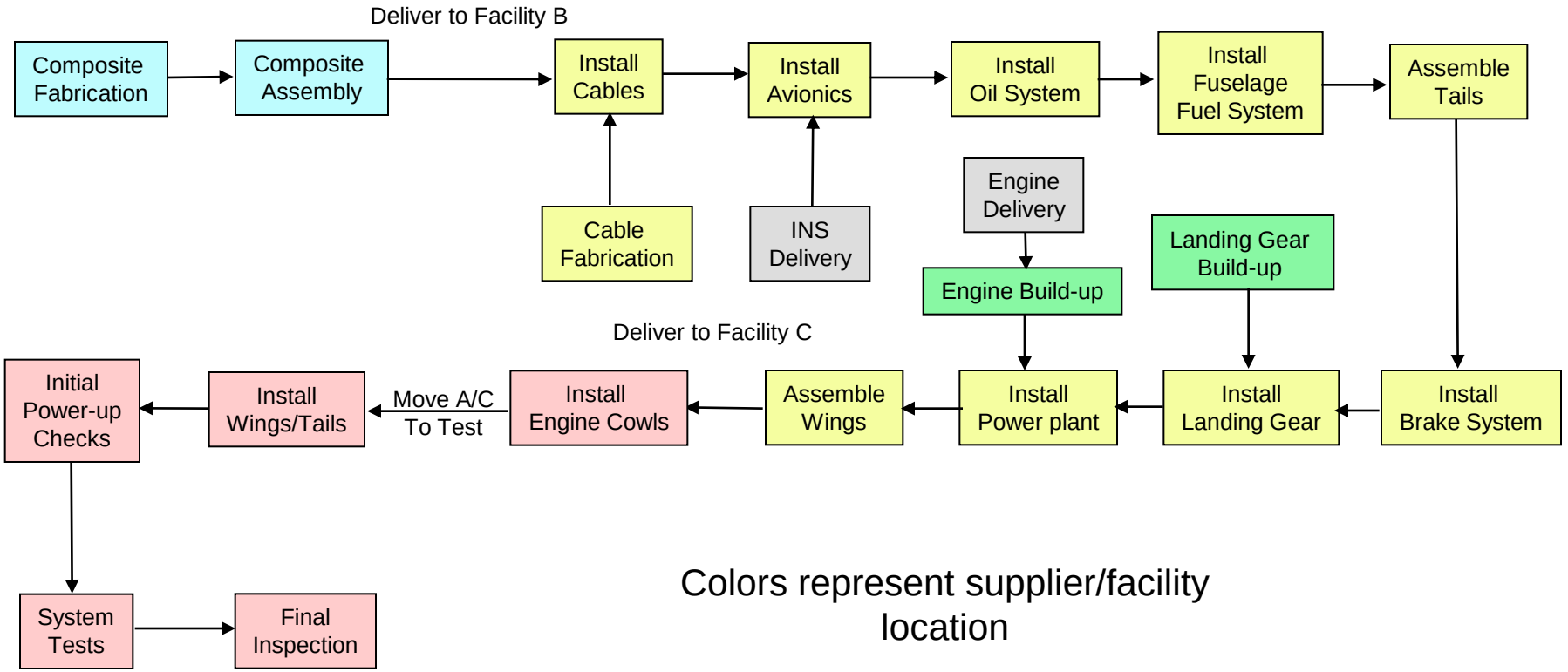
- **Assessment Team Lead briefs PM on manufacturing assessment efforts/expectations**
  - **Determine appropriate level for MRA(s)**
    - **System may contain several critical technologies/components/manufacturing cells**
  - **Schedule on-site MRA with contractor(s)**
  - **Send questionnaire to contractor(s)**
  - **Define assessment team membership**
  - **Define deliverables of assessment results**
  - **Conduct on-site assessment with contractor(s)**
  - **Develop Manufacturing Maturation Plan (MMP)**
  - **Determine risk of reaching target MRL**
  - **Deliver final report/briefing**

Identifying Technologies That Need to be Assessed
(Critical Technologies)

- **A "yes" to any of the below is an indication that the technology should be assessed for manufacturing readiness**
  - **Are there materials which have not been demonstrated in similar products or manufacturing processes?**
  - **Is the technology new with high cost uncertainty?**
  - **Is the item design novel or does it contain nonstandard dimensions or tolerances or arrangements?**
  - **Will the item require the use of manufacturing technology, processes, inspection, or capabilities that are unproven in the current environment?**
  - **Does the item have historical/anticipated yield or quality issues?**
  - **Does this item require a new manufacturing facility or scale up of existing facilities?**
  - **Is this a critical item manufactured by a sole or foreign source?**

Example Process Flow
Generic Aircraft

- **Large programs can require multiple MRAs**



Colors represent supplier/facility location

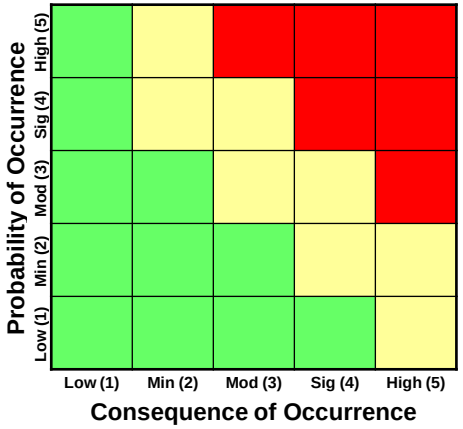
MRA Deliverables

Provide briefing and/or written report

- **Identify current MRL/target MRL**
- **Identify key factors where manufacturing readiness falls short of target MRL**
  - **Define driving issues**
- **Identify programs and plans to reach target MRL**
- **Assess type and significance of risk to cost, schedule or performance**
- **Next step: Stay engaged to assist in implementing and executing the MMP**

SAMPLE MRA Risk Management

- **Assessing Risk is Independent of the MRL Value Assigned**
  - **Higher MRL Value may be Highest Risk**
    - **Eg. Requires New Equipment, High Cost Process**
- **Risk Assessment should consider**
  - **Time Needed to Reach Target MRL**
  - **Require New Personnel, Training, or Capital**
  - **Leverage Other Programs**
  - **Supplier Dependency??**
  - **Part of a Company's Core Business**
    - **Leads to an Industrial Base Assessment**



- **Effective of Use of Design for Manufacturing Tools and Other Simulation Techniques.**

Some MRL Thoughts

- **MRLs are not a report card**
  - ***MRL 7 might not be good***
  - ***MRL 3 might not be bad***

- **MRLs are a tool to manage and mitigate manufacturing risk**
  - ***A common language used to assess manufacturing maturity***
  - ***Provide insight not <u>oversight</u>***

Findings and Conclusions

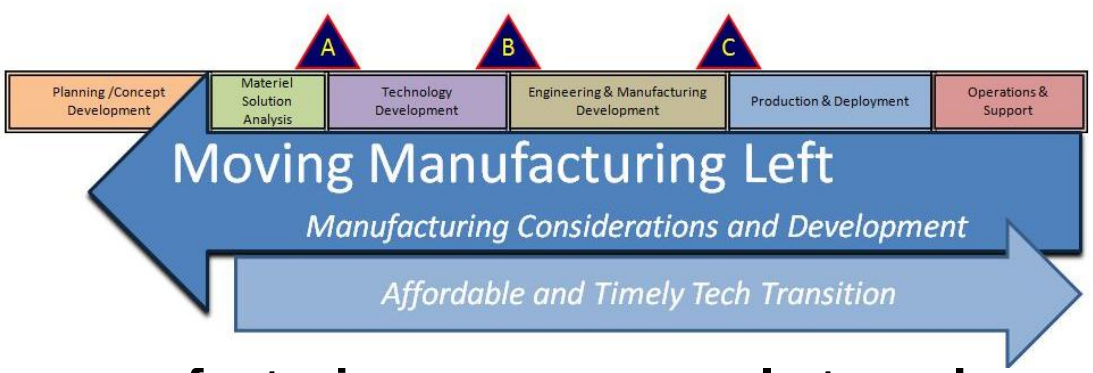
- **Looking at transitioning technology to production**
  - **Must incentivize good decision-making processes;**
  - **Unlike TRLs, going backwards on MRLs might be a good thing**
- **A low MRL number may be OK**
  - **Is there time to raise the level?**
  - **Is there a new manufacturing process being pursued?**
  - **Replacing a manual process with an automated process**
    - **Encouraging repeatability, faster cycle time, etc.**
- **Identify opportunities to validate manufacturing processes**
  - **Avoid accepting analogous process claims during the design phase and claiming fabrication is maturing**
- **May never build enough units to reach MRL 10**
  - **Achieve a Six Sigma or equivalent process**
  - **Stable line, may require a multi-product factory**

Some MRA Lessons Learned

- Process is more effective if company is actively engaged in the assessment
- System integration and test operations are often ripe for maturation efforts
- Resources required to conduct an MRA will vary significantly
- Subject matter expertise is needed to "do it right"

"I work S&T, why should I be worried about manufacturing"?

"You can pay me now, or pay me later"



- **Address manufacturing concerns early to reduce risk later**
  - **Technical – remove manufacturing barriers that slow technology transition**
  - **Affordability – cost avoidance**
  - **Transition speed and acquisition schedule slip – rapid response technology solutions are necessary**

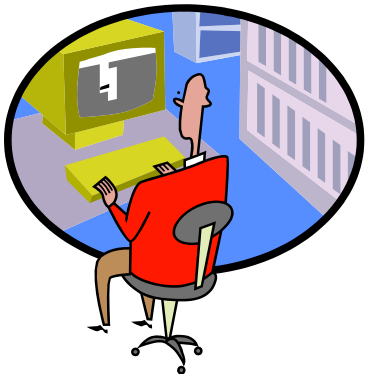
MRLs in S&T

Minimal effort with possible huge payoff!

- **S&T**
  - **6.1 Projects – MRLs 1&2**
    - **Limited applicability**
    - **Can be used to characterized a top level assessment of the manufacturing risk of the project**
      - **Provide insight into new manufacturing processes that need to be developed to achieve innovative new products.**
  - **6.2 Projects – MRLs 1-4**
    - **Provides an assessment of the manufacturing feasibility of the S&T project**
    - **Should be useful in deciding the next steps**
  - **6.3 Projects – MRLs 3-6**
    - **A valuable tool in assessing and maturing manufacturing capability for new technology**
    - **Should be major concern to whomever receives the technology**
    - **Could be funded by either S&T or Acq – or ignored and transition technology w/o risk understood**
  - **ManTech – critical tool to assess and demonstrate manufacturing maturity – essential to effectively implement into acquisition programs**
- **MRLs have value in S&T – some work remains in refining the process for the S&T Community**

MRL/MRA Resources

- **Found at www.dodmrl.com or www.dodmrl.org**
  - **MRL Deskbook – the "how to" of MRAs**
  - **MRL Criteria**
  - **MRL definitions**
  - **MRL users guide**
  - **Under AF ManTech's MRA Tool**
    - **Air Force ManTech MRA Questions**
- **Jim Morgan, AFRL/RXMS, 674-4600, James.Morgan.26@us.af.mil**



"Without materials and manufacturing, you'll never make it..."

Summary

- MRL processes are well defined
- MRLs are being used by DOD and Industry
- Utilizing MRLs in S&T - minimal investment, huge return
- ManTech and MRL Working Group addressing MRL use in S&T – stay tuned!

MRL use in S&T can help bridge the "valley of death"

Addendum

- **A deeper dive into MRA processes**

Supplier MRA Plan

- Identify and prioritize critical suppliers
- Develop common SOW for distribution to suppliers
  - Scope of MRA detailed
  - Method of MRA detailed
  - Output defined
- Developed detailed MRA execution plan with each supplier (schedule, format, personnel)
- Execute MRA
- Define/plan/execute MRL MMP
- Measure mitigation effectiveness, update assessment

On-site MRA Process Review

- Contractor welcome, review of agenda and orientation to facility
- Introduction of assessment team and contractor personnel
- Government team lead briefing to contractor describing objectives and expectations for the on-site visit
- Contractor overview and discussion of the results of their self-assessment
- Shop-floor visits to key areas by individuals or small groups
- One-on-one or small group discussions between assessment team members and contractor subject matter experts focused on key areas
- Private meeting of Government assessment team to:
  - Prepare feedback and identify any action items
  - Initial assessment of current MRL (their area or overall)
  - Key strengths/risks/issues
  - Key missing data (if any)
  - Proposed action items
- Outbriefing by Government team to contractor

SAMPLE SUMMARY ROLL-UP OF COMPONENTS

SubSystem	Top Level MRL	Observations	Most Critical
Guidance	3	- Lacking detailed process information - Key suppliers identified; Need key performance parameters - Need detailed process plans	Detector from supplier A - Design & production issues - No alternate source
Data Processor	3	- New processor architecture -Immature design tools - New attachment processes needed	Board Supplier can't test at their site Low yields on initial run
Propulsion	6	- Same as other systems in use - New component scheme	Re-validate manufacturing process Supplier handle increased rate
Air Vehicle	7	- Same supplier as system X - Need to test new mating and assembly processes at the prime	No critical items
Test Plan	6	Several instances of re-design work and new test processes	- New test strategy and plan - What will new design incorporate? - Manufacturing experience vital

SAMPLE SUMMARY (Drill down)

Guidance Sub systems	Top Level MRL	Observations	Most Critical
Front End Sensor	3	- Lacking details on builds - Process procedures need more work - Test and assembly procedures have not been verified in manufacturing environment	Detector from supplier A - Design & production issues - No alternate source
Data Processing PWB	3	- New processor architecture -Awaiting Design for Manufacturing and Assembly (DFMA) results	Low yields on initial build Working process controls Looking at re-design for easier fabrication
Cables For: Power Data	3	- Using same suppliers other weapon systems - Have not received prototypes, awaiting supplier delivery	Re-validate manufacturing process as seen on past programs Need new process plan
Housing	4	- New supplier: limited experience - Need new assembly processes at the prime	Need supplier management process; need new process plans
Cooling	3	- Form, fit factors for new cooling design not in place Initial process plan for build in place	Final cooling plan will be defined after front end is stable
Integration Process that includes assembly and test	3	- Several new test processes need development for new components	New test strategy and plan New special test equipment must be ordered

Follow-on Activities

- Gather any key missing data
- Convene team meeting - typically within 2 weeks of on-site assessment
  - Discuss and finalize assessment
  - Examine current program and manufacturing risk reduction plans
  - Agree on likely MRL at completion of milestone if current plan is followed
- Share results with contractor
- Identify the specific risk reduction activities necessary to reach the next milestone
- Identify the funding, time-phasing and approach to carrying out each activity
- Prepare and submit final report