Technology & Manufacturing Readiness Assessments @ RMS

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April 17, 2008
Contents

- History of Technology & Manufacturing Readiness Assessment (T&MRA) Activities at RMS
- T&MRA Project
- Lessons Learned
History of T&MRA Activities at Raytheon Missile Systems (RMS) – 2005 & 2006

- **2005**
  - RMS leader attended Defense Acquisition University course…first delivery of Manufacturing Readiness Level (MRL) materials
  - ManTech white papers, quad charts & proposals require MRLs & notional MRL Maturity Plans (MMP)

- **2006**
  - RMS employees attended MRA training course established by Air Force Research Lab (AFRL)
  - 2-Part Pilot MRAs conducted by AFRL on AMRAAM Program
  - RMS Kicked-off T&MRA Project with Raytheon Six Sigma Team
  - Full Time MRA Manager assigned to Air-to-Air Product Line
  - Joint Service ManTech Program Awarded, required MMP
  - Conducted first independent T&MRA on Radome portfolio
  - T&MRA @ RMS website goes live
It Simply Makes Good Business Sense!

- Establishing TRLs, MRLs and maturity plans in accordance with the DoD’s TRA & MRA requirements is not only necessary to support customer led assessments, but also:
  - T&MRA processes can **change the culture** by driving a collaborative partnership between programs, design and manufacturing engineering earlier in the product development life cycle where maturity efforts can have greatest impact on **improving program affordability and predictability**
  - Lower risk designs lead to shorter development cycles with fewer design re-starts, more accurate delivery dates, and lower overall development costs
    - Can mitigate 20% post CDR cost growth trend noted in GAO reports
    - Cost reductions of 30% or more can be achieved
Technology & Manufacturing Readiness is integrated and measured in RMS business practices and culture.

Established TRA Process:
Technology Readiness Assessment

New MRA Process:
Manufacturing Readiness Assessment
T&MRA @ RMS Project Focus Areas

- **Awareness & Training**
  - T&MRA socialization across RMS & Raytheon
  - T&MRA preparation and facilitation training

- **T&MRA Knowledge Management**
  - Environmental scanning, knowledge capture, information warehousing & easy access (e.g. website, docushare and eRooms)
  - Capture lessons learned from internal & external cycles of learning
  - Assist DoD in the shaping MRA regulations, policies, and processes

- **Standardization of T&MRA @ RMS Processes**
  - 10-Step process created (includes capture of lessons learned)
  - Aligned with DoD MRA process, combined with DoD’s TRA

- **Directive System Support**
  - Modify Directives, Proposals, Contracting, Practices, Instructions, etc. to support consistent and compulsory deployments
T&MRA Website for Knowledge Capture & Reuse

Links
• Defense Acquisition University
• Defense Acquisition Guidebook
• Acquisition Community Connection
• DAU - Manufacturing Readiness Assessments
• DoD ManTech
• MRL Assist

T&MRA Tool Box
• MRL Matrix & Definitions+
• T&MRA Baseline & Planning Workbook
• TRL HW & SW Definitions (DAG October 2004)
• T&MRA Summary Report Template

Reference Materials
• 2007 Defense Manufacturing Conference
• 2007 Technology Maturity Conference
• AFRL MRA Workshop - 2006 DMC
• DoD Integrated Management Framework - Back
• DoD Integrated Management Framework - Front
• GAO-07-706SP Assessments of Selected Weapon Programs, March 2007
• Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, Version 2.0, June 2005
• Misc. T&MRA Presentations
• T&MRA Process Training
• T&MRA Overview
• Technology Readiness Assessment (TRA) Deskbook, May 2005
History of T&MRA Activities at RMS - 2007

- T&MRA 10-Step Process developed – aligned with MRA
- T&MRA awareness seminars conducted across RMS
- Project Lead attended 2-week DAU course with DoD PMs; teams conducted notional MRAs from GAO facts & data
- MRAs considered good Management practice - not plus-ups
- T&MRL baselines in 3 major proposals (lessons learned)
- T&MRA added to RMS Manufacturing Excellence Model
- Early T&MRL requirements for Architectural Review Boards
- Participated in JDMTP’s MRA Working Group with Industry
- “T&MRA @ RMS” presented at Raytheon Symposia and Defense Manufacturing Conference
- MRL maturity included in Operations Strategy and Reviews
Combined “Technology & Manufacturing Readiness Assessment” Model

1. Establish Team
2. Id “key” technologies
3. Assess TRL
4. Assess Transition Readiness
5. Prepare TMP (Technology Maturity Plan)
6. Assess MRL
7. Assess Transition Readiness
8. Customer agreement to proceed with immature technology
9. Plan Status Reviews
10. Knowledge Capture

Flowchart:

- Establish Team
- Id “key” technologies
- Assess TRL
  - TRL meets product development maturity requirements
  - Customer agreement to proceed with immature technology
- Assess Transition Readiness
- Prepare TMP (Technology Maturity Plan)
- Assess MRL
  - MRL meets maturity requirements
  - Customer agreement to proceed with immature technology
- Plan Status Reviews
- Knowledge Capture
History and Plans for T&MRA Activities at RMS - 2008

- T&MRA detailed 10-step process training developed
- T&MRA tools refined and added – to assess current state, develop maturity plans, report progress and document T&MRA
- Corporate IPDS Change Review Board scheduled to review T&MRA for potential incorporation into IPDS to ensure consistent and compulsory deployment in 2008
- T&MRA project lead scheduled to present “T&MRA @ RMS” at this year’s:
  - National Defense Industry Association (NDIA) Science & Engineering Technology Conference in April
  - Enterprise Process Group Workshop in July
Tool to Capture, Plan and Status T&MRLs and Maturity Plans

- Tool created to demo important T&MRA planning & reporting characteristics
  - Facilitates and documents the Baseline & Current State T&MRLs by MRL Matrix Thread
  - Potential to roll-up 10 separate technology assessments to an assembly level TRL & MRL
  - Transition Risk Color Coding based on DoD Best Practices for each phase of PDLC

<table>
<thead>
<tr>
<th># MRL Matrix Evaluation Threads</th>
<th># MRL Matrix Sub-Thread</th>
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</thead>
<tbody>
<tr>
<td>1 Technology &amp; Industrial Base</td>
<td>1 Technology Readiness Level (TRL)</td>
</tr>
<tr>
<td>2 Technology Transition to Production</td>
<td>2 Technology Readiness Level (TRL)</td>
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<tr>
<td>3 Manufacturing Technology Development</td>
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<td>4 Design</td>
<td>4 Productivity Program</td>
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<td>5 Design Maturity</td>
<td>5 Design Maturity</td>
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<td>6 Materials</td>
<td>6 Maturity</td>
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<tr>
<td>7 Availability</td>
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<td>8 Supply Chain Management</td>
<td>8 Supply Chain Management</td>
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<tr>
<td>9 Special Handling</td>
<td>9 Special Handling</td>
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<tr>
<td>10 Cost &amp; Funding</td>
<td>10 Production Cost Knowledge (Cost Modeling)</td>
</tr>
<tr>
<td>11 Unit Production Costs</td>
<td>11 Unit Production Costs</td>
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<tr>
<td>12 Manufacturing Investment Budget</td>
<td>12 Manufacturing Investment Budget</td>
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<tr>
<td>13 Process Capability &amp; Control</td>
<td>13 Modeling &amp; Simulation (Product &amp; Process)</td>
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<tr>
<td>14 Manufacturing Process Maturity</td>
<td>14 Manufacturing Process Maturity</td>
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<tr>
<td>15 Manufacturing Technology Initiatives</td>
<td>15 Manufacturing Technology Initiatives</td>
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<td>16 Process Yields &amp; Rates</td>
<td>16 Process Yields &amp; Rates</td>
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<td>17 Quality Management</td>
<td>17 Quality Management Including Supplier Quality</td>
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<td>18 Manufacturing Personnel</td>
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<tr>
<td>19 Facilities</td>
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<tr>
<td>22 Tooling &amp; Special Test Equipment</td>
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Transition Readiness Risk Guide by PLC Phase

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<th>CR</th>
<th>TD</th>
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Tool created to demo important T&MRA planning & reporting characteristics
- Facilitates and documents the Baseline & Current State T&MRLs by MRL Matrix Thread
- Potential to roll-up 10 separate technology assessments to an assembly level TRL & MRL
- Transition Risk Color Coding based on DoD Best Practices for each phase of PDLC
# T&MRL Maturity Planning for Each Technology Assessed

- Plan vs Actual TRL and MRL with transition readiness risk color codes
- Detailed tasks, POC, rationale, dates, funding, and sources of funding
- “What-if?” analysis capability

**Program:** Hypersonic Missile Program  
**Product Description:** Guidance & Navigation Unit  
**Product Development Phase:** Technology Development  
**Transition Readiness Goals:** 6  
**T&MRL Valuation Method:** Lowest T&MRL Values

<table>
<thead>
<tr>
<th>Item #</th>
<th>Task Description</th>
<th>Rationale/Evidence/Risks to Completion</th>
<th>Responsible POC</th>
<th>Plan Due Date</th>
<th>Complete Date</th>
<th>MRL Increase</th>
<th>Funding Req'ts</th>
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- MRL funding plan: $1,765 K  
- Current MRL: 5  
- MRL Plan Complete? Y  
- In Risk Register? N

**Key Technology Assessed:** Sensor  
**Acronym:** Acronym 1

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Key Lessons Learned

- Cultural change...T&MRA is a means to facilitate earlier collaborations between design engineering, manufacturing and supply chain during any phase of PDLC
- Leadership & Assessment Team alignment required before T&MRA deployments
- TRLs & MRLs should be established at the critical technology levels (best practice)
- Wherever possible, the T&MRA should be completed prior to developing a proposal to ensure technology, design & manufacturability risks are accounted for:
  - Assess program feasibility and technology transition readiness (risks)
  - Program cost and schedules should include maturity plans and goals
  - Identify key manufacturing processes that need to be matured for program success
Key Lessons Learned

- Command media revisions required for consistent & compulsory use
- Tailoring of assessment based on fidelity level desired
- MRA and Production Readiness are not the same
- Systems Engineering organization to own the T&MRA process
- Need further development and integration of tools and management systems to capture, plan and report T&MRL progress
- MRL Matrix can be enhanced further to focus on Manufacturing Process Maturity
- **Low MRLs are not necessarily an issue…not having a maturity plan is!**
In Summary...

- TRLs are part of our culture at Raytheon…more discipline required
- MRLs are relatively new…Industry is still in early stages of adoption
  - Sense of urgency within the DoD – TRA & MRA processes are being taught to and deployed by our customers…and for very compelling reasons
  - Acquisition Policy, Guidance and Legislation associated with TRA & MRA are in place and/or currently under revision & development for 2008 release
- The use of T&MRA processes will not guarantee program success
- T&MRA processes and tools will:
  - Change culture - bridge the divide between engineering & manufacturing
  - Provide insight into current state technology & manufacturing maturity and capability
  - Identify contributing factors & issues driving the “Gaps” in T&MRL maturity
  - Identify the type and significance of risks to program cost, schedule and performance
  - Lead to more accurate, time phased, and priced maturity plans
  - **Improve program affordability and predictability**
If you have any questions, feel free to contact me at:

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