Implementation of the Reliability & Maintainability (R&M) Engineering Body of Knowledge (BoK)

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Office of the Deputy Assistant Secretary of Defense for Systems Engineering

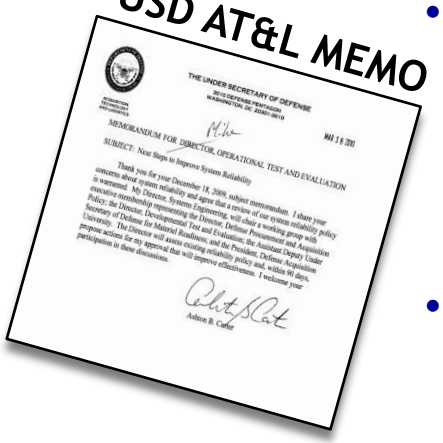
20th Annual NDIA Systems Engineering Conference
Springfield, VA | October 25, 2017

Agenda

- **Policy**
- **Guidance/Body of Knowledge**
- **Workforce Development**
- **Instantiating the Body of Knowledge**

Policy
Reliability Analysis, Planning, Tracking and Reporting

USD AT&L MEMO


THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

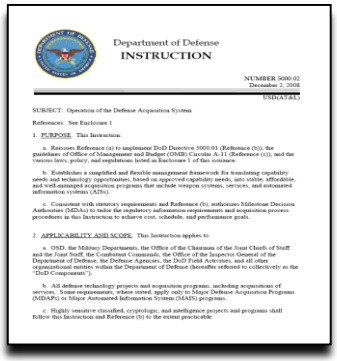
MEMORANDUM FOR DIRECTOR, OPERATIONAL TEST AND EVALUATION

SUBJECT: Next Steps to Improve System Reliability

Thank you for your December 18, 2009, subject memorandum. I share your concern about system reliability and agree that a review of our system reliability policy is warranted. My Director, System Engineering, will chair a working group with executive membership representing the Director, Defense Procurement and Acquisition Policy; the Director, Developmental Test and Evaluation; the Assistant Deputy Under Secretary of Defense for Materiel Readiness; and the President, Defense Acquisition University. The Director will assess existing reliability policy and, within 90 days, propose actions for my approval that will improve effectiveness. I welcome your participation in these discussions.

Ashton B. Carter

DoDI 5000.02


Department of Defense
INSTRUCTION

NUMBER 5000.02
December 2, 2008
USD(AT&L)

SUBJECT: Operation of the Defense Acquisition System

References: See Enclosure 1

1. PURPOSE. This Instruction:

a. Reissues Reference (a) to implement DoD Directive 5000.01 (Reference (b)), the guidelines of Office of Management and Budget (OMB) Circular A-11 (Reference (c)), and the various laws, policy, and regulations listed in Enclosure 1 of this issuance.

b. Establishes a simplified and flexible management framework for translating capability needs and technology opportunities, based on approved capability needs, into stable, affordable, and well-managed acquisition programs that include weapon systems, services, and automated information systems (AISs).

c. Consistent with statutory requirements and Reference (b), authorizes Milestone Decision Authorities (MDAs) to tailor the regulatory information requirements and acquisition process procedures in this Instruction to achieve cost, schedule, and performance goals.

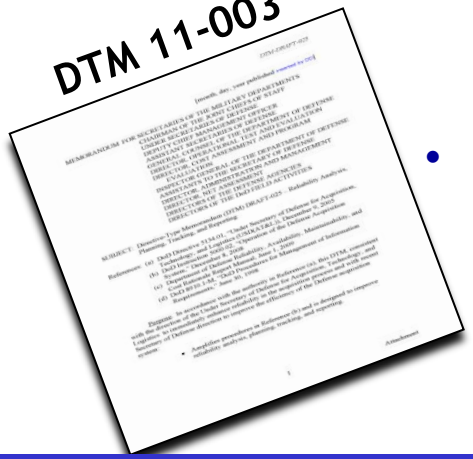
2. APPLICABILITY AND SCOPE. This Instruction applies to:

a. OSD, the Military Departments, the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the Department of Defense (hereafter referred to collectively as the "DoD Components").

b. All defense technology projects and acquisition programs, including acquisitions of services. Some requirements, where stated, apply only to Major Defense Acquisition Programs (MDAPs) or Major Automated Information System (MAIS) programs.

c. Highly sensitive classified, cryptologic, and intelligence projects and programs shall follow this Instruction and Reference (b) to the extent practicable.

DTM 11-003


MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
DIRECTOR, DEFENSE RESEARCH AND ENGINEERING
ASSISTANT SECRETARIES OF DEFENSE
GENERAL COUNSEL OF THE DEPARTMENT OF DEFENSE
DIRECTOR, OPERATIONAL TEST AND EVALUATION
ASSISTANTS TO THE SECRETARY OF DEFENSE
DIRECTOR, ADMINISTRATION AND MANAGEMENT
DIRECTORS OF THE DEFENSE AGENCIES
DIRECTORS OF THE DOD FIELD ACTIVITIES

SUBJECT: Directive-Type Memorandum (DTM) 11-003 – Reliability Analysis, Planning, Tracking, and Reporting

- Impetus for Reliability Policy (Mar 2010)
  - Directed by Dr. Carter in response to memo from DOT&E (Dec 2009)
  - DASD(SE) to assess existing reliability policy and propose actions to improve effectiveness
- DoD Acquisition Policy (DoDI 5000.02)
  - Does not adequately or uniformly consider R&M engineering activities throughout the acquisition process
  - Fails to capture R&M planning in new or existing acquisition artifacts to inform acquisition decision making
- DTM 11-003 (Approved 21 Mar 2011)
  - Amplifies current DoDI 5000.02 by requiring PMs to perform reliability activities
  - Institutionalizes planning and reporting timed to key acquisition activities

DTM 11-003 was instantiated into DoDI 5000.02 in January 2015

Establishing an Effective R&M Engineering Program

Capability Description Document

5000.02 Enclosure 3 SE R&M Requirements

Engineering Activities

- R&M allocations, block diagrams and predictions
- Failure definitions and scoring criteria
- Failure Mode, Effects and Criticality Analysis (FMECA)
- Built-in Test (BIT) and maintainability demonstrations
- Reliability Growth testing at system/subsystem level
- Failure Reporting, Analysis and Corrective Action System

Preliminary RAM-C Report in support of Milestone (MS) A and updated for RFP Release Decision Point, MS B, & MS C

- Provides an audit trail that documents and supports JCIDS thresholds
- Ensures correct balance between the sustainment metrics (Availability-KPP, Materiel Reliability-KSA, and O&S Cost-KSA)
- Provides early risk reduction by ensuring sustainment thresholds are realistic (feasible) and correct (valid)

Reliability Growth Strategy

- Documents system-level reliability growth curves in the SEP beginning at MS A and updated in the Test & Evaluation Master Plan (TEMP) beginning at MS B
- Establishes intermediate goals for reliability growth curves that will be tracked through fully integrated system-level T&E events until the threshold is achieved
- Requires MS C PMs and Operational Test Agencies to assess reliability growth required to achieve the reliability threshold during IOT&E

Tracking and Monitoring

- Requires PMs to report status of reliability objectives and/or thresholds as part of the formal system engineering review process
- Incorporates Reliability Growth Curves into the DAES review process

Detailed Planning and Timing

System Engineering Plan

Statement of Work

R&M Thresholds & Requirements

Summary List of R&M Activities

Acquisition Strategy

Translation of JCIDS Thresholds to Spec Design Requirements

System Performance Specification

Program Execution and R&M Engineering BoK

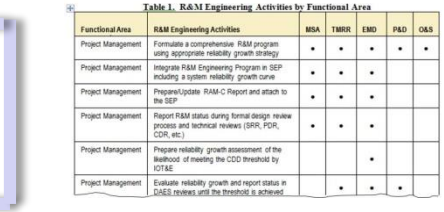


Table 1. R&M Engineering Activities by Functional Area

Functional Area	R&M Engineering Activities	MSA	TMRR	EMD	P&D	O&S
Project Management	Formulate a comprehensive R&M program using appropriate reliability growth strategy	•	•	•	•	•
Project Management	Integrate R&M Engineering Program in SEP including a system reliability growth curve	•	•	•		
Project Management	Prepare/Update RAM-C Report and attach to the SEP	•	•	•		
Project Management	Report R&M status during formal design review process and technical reviews (SRR, PDR, CDR, etc.)	•	•	•		
Project Management	Prepare reliability growth assessment of the likelihood of meeting the CDD threshold by IOT&E			•		
Project Management	Evaluate reliability growth and report status in DAES reviews until the threshold is achieved		•	•	•	

R&M Service Leadership Coordination

- **Meetings with R&M Service leadership**
  - Provide update on what is happening within DoD regarding R&M engineering
  - Discuss R&M workforce development
  - Review strategies to better connect policy and guidance with program execution
  - Discussions on various R&M topics such as R&M standardization, predictions and derating, RAM-C update, and software
- **Participation in annual Reliability and Maintainability Symposium (RAMS®)**
  - DoD/Industry Roundtable: R&M Service leadership and their industry counterparts share challenges and solutions
- **Provide status and feedback of program execution to R&M service leads.**
  - Identify systemic areas that require improvement or guidance
  - Provide feedback to workforce development i.e., DAU

R&M Engineering Body of Knowledge (BoK)

- **The BoK is organized in the following three areas:**
  - First, by the defense acquisition life cycle phases
  - Second, by functional area (Project Management, Systems Engineering, Test and Evaluation, Procurement)
  - Third, each functional area lists R&M engineering activities that trace back to the required R&M engineering activities established in DTM 11-003

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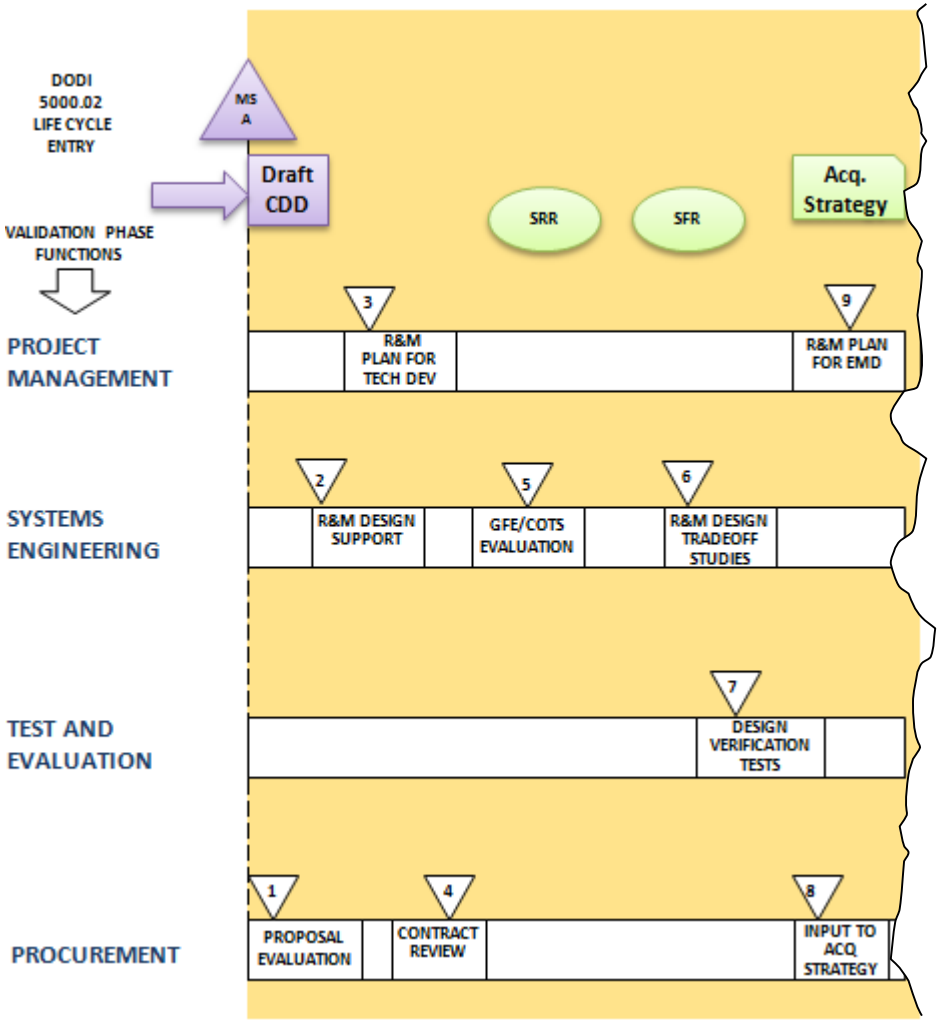
Some activities occur in more than one phase

R&M Engineering BoK Functional Areas

- **The BoK defines and allocates R&M activities to the functional areas into which a materiel acquisition program can normally be divided:**
  - Project Management
    - Planning, definition, and implementation of R&M control criteria, assurance procedures, in-process review for compliance, and R&M decision-making criteria
  - Systems Engineering
    - R&M design analyses, trade-off study, failure mode effects and criticality analysis, R&M problem and correction, and R&M design support
  - Test and Evaluation
    - Planning and conducting tests for evaluation and demonstration of R&M
  - Procurement
    - Definition, documentation, and review of R&M requirements and provisions in procurement requests, requests for proposals, contracts and exhibits
- **R&M engineering activities should be properly integrated across all functional areas of the program in order to implement an effective R&M engineering program**

R&M Engineering BoK Activity Overview

- **The BoK identifies specific activities needed to support each DTM-required R&M engineering activity**
  - MSA phase – 13
  - TMRR phase – 14
  - EMD phase – 14
  - P&D phase – 13
  - O&S phase – 5
- **Each acquisition phase has a figure showing timelines for the activities for each functional area**



BoK Application Example

- **Program has progressed to TMRR phase**
- **Determine that a required engineering activity is to "Formulate a comprehensive R&M program using appropriate reliability growth strategy"**

Table 1. R&M Engineering Activities by Functional Area

Functional Area	R&M Engineering Activities	MSA	TMRR	EMD	P&D	O&S
Project Management	Formulate a comprehensive R&M program using appropriate reliability growth strategy	•	•	•	•	•

- **Activity associated with the TMRR phase is part of the Project Management functional area**

Table 2-3. Project Management R&M Tasks – TMRR Phase

R&M Task		Description
3	Develop/review R&M planning for TMRR phase	Review the R&M plans to ensure conformance to requirements defined in the RFP and contract and to verify consistency with requirements and provisions.

BoK Application Example

- **Each activity in each phase has an activity overview, control procedure, data requirements, and review criteria**
  - **Overview of activity**
    - Brief description of the activity and its importance
  - **Control Procedure**
    - Procedure that should be followed in accomplishing the activity
  - **Data Requirements**
    - Data required to complete the activity
  - **Review Criteria**
    - Criteria to be used in determining if the activity has been completed successfully

TMRR Phase Activity 3

2.1.1 Develop/Review R&M Planning for TMRR Phase

TASK 3

The R&M engineer and project management team review the R&M program planning for the TMRR phase that the Government developed before initiating the TMRR phase and contract. The team updates the planning as appropriate to reflect specification changes approved during negotiations.

……

R&M PLANNING for TMRR: CONTROL PROCEDURE

The Government R&M planning for the TMRR phase should be updated from the MSA phase. (MIL-HDBK-338B Section 12, MIL-HDBK-470A Section 4.2 and Appendix A, MIL-HDBK-2165 Task 100 and Appendix A) The planning as a minimum should address the following in the appropriate program planning documents:

- *Management* – Identify the organizational elements and personnel and clearly define their responsibilities and functions.
- *Management Tasks* – Prepare a detailed listing and description of each R&M task and the procedures to evaluate the status of and to control each task.
- *Resources* – Estimate the Government R&M funding and man-hours for each R&M task (or task that the R&M team is involved in) required in the TMRR phase.
- *Objectives* – Determine provisions for updating the quantitative and qualitative R&M objectives to reflect the current approved configuration and the related analyses and trade-off studies.
- *Problem and Risk Areas* – Establish procedures for identifying critical R&M problems and risks and the plans for resolving and mitigating these problems in the TMRR phase.
- *Acquisition Program Documents* – Provide steps for updating the R&M inputs to the Systems Engineering Plan (SEP), Acquisition Strategy (AS), the RAM-C Report, the Test and Evaluation Master Plan (TEMP), and other program documents as required……..

R&M PLANNING FOR TMRR: DATA REQUIREMENTS

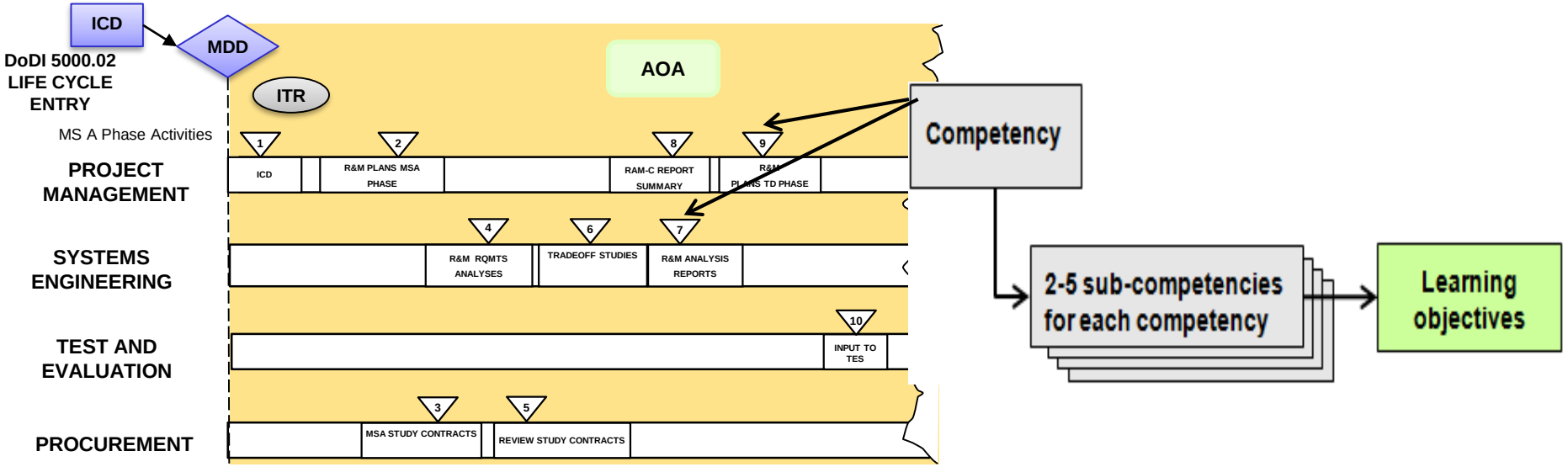
The contractor's R&M program plans should include the data requirements outlined above and as required by the RFP. The Government should review these plans in preparation for the System Requirements Review (SRR). The plans should allow for updating as plans or procedures change by mutual agreement to conform to the needs of the program. Essential features of the contractor's approved R&M plans should be integrated into appropriate sections of the SEP and internal program documents including technical review entrance criteria.

R&M PLANNING FOR TMRR: REVIEW CRITERIA

- The contractor's R&M program plans satisfy the requirements outlined in the control procedure and data requirements above.

Workforce Development

R&M Competencies

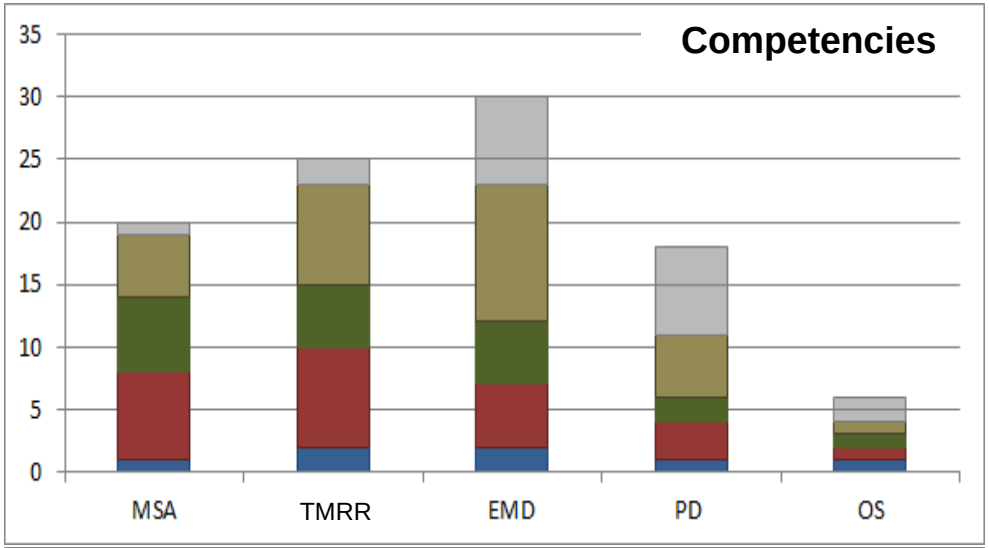


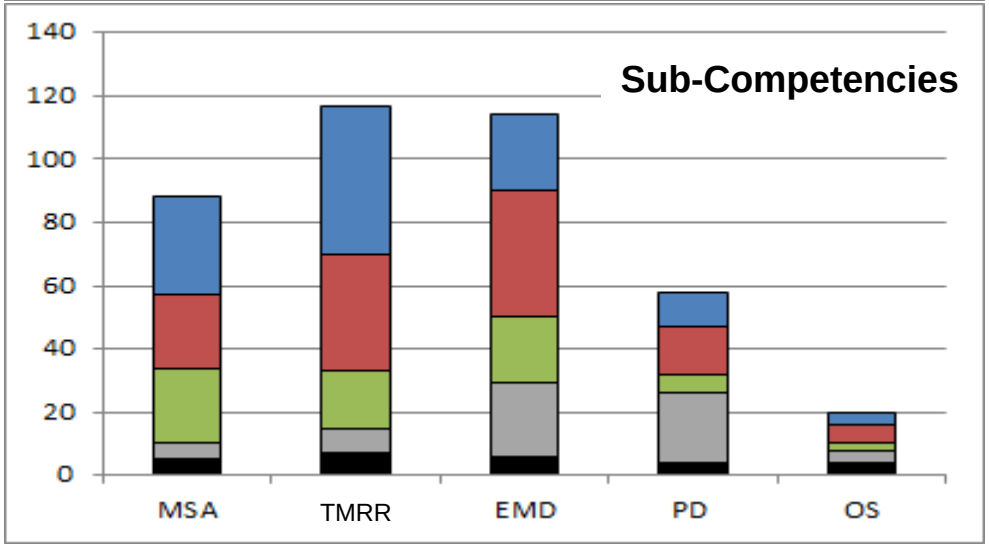
- **Competencies are focused by program functional areas**
- **Developed competencies, sub-competencies, and supporting standard skills for basic, intermediate, and advanced career levels to support learning architecture development**
- **Mapped sub-competencies to DAU courseware learning objectives**

The R&M competency structure spans the acquisition life cycle, and addresses all levels of proficiency

R&M Competencies
by Acquisition Phase and Functional Area

- **DoD R&M Competencies and Sub-competencies show population distribution across acquisition phases**
- **Technical project management (includes planning activities) and systems engineering contain greatest number of competencies**
- **All functional areas are present in each acquisition phase, although the relative weightings may change**



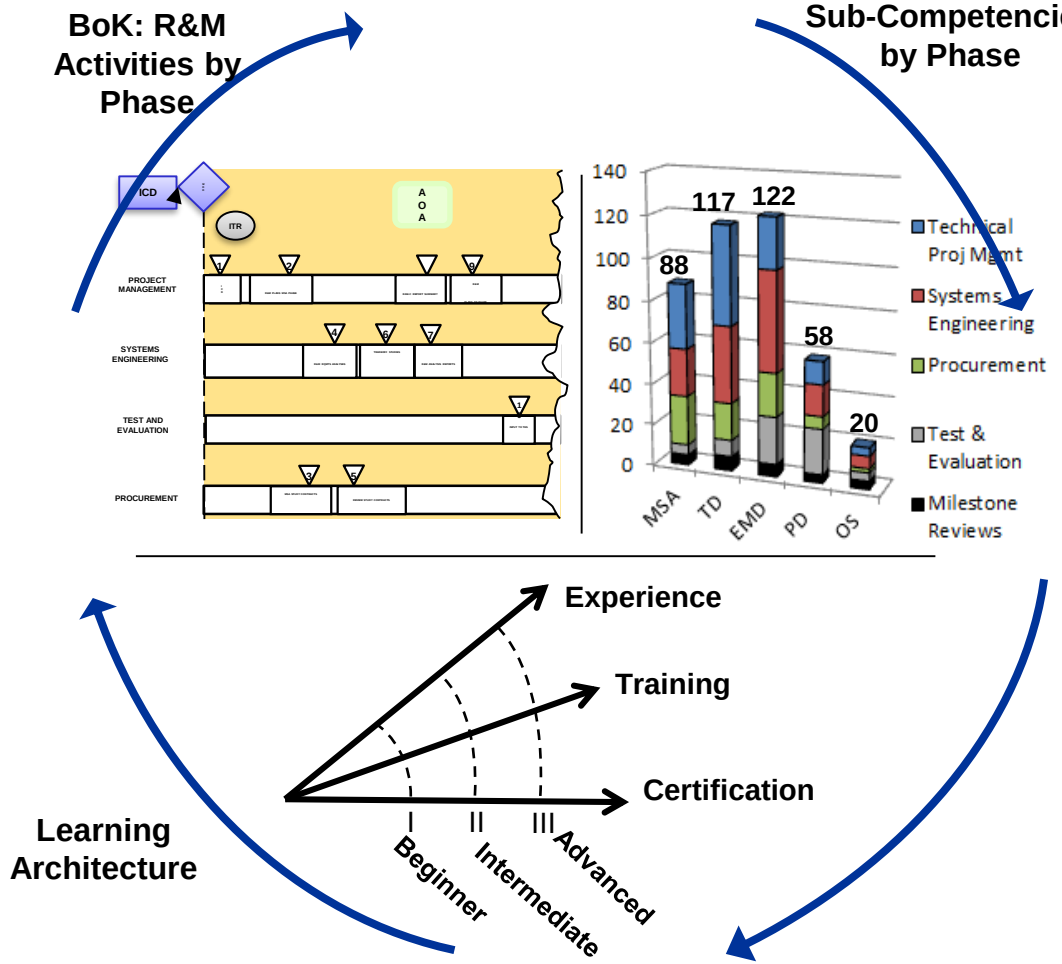


R&M Engineering Learning Architecture

- **Purpose: career development guidance for the R&M Engineer**
- **R&M Learning Architecture – consolidation of desired:**
  - **Education**
  - **Experiences**
  - **Training Available to the DoD community**
- **Defined body of knowledge for each DAWIA Level**
- **Organizes R&M experiences and training within each DAWIA level**
  - **R&M Engineering / Acquisition**
  - **R&M Design Analysis**
  - **R&M Product Support Planning**
  - **R&M Test**
  - **R&M Procurement**

Workforce Development

R&M Engineering Learning Architecture



- DoD R&M Engineering Competency Structure Requires a Comprehensive Learning Architecture
- R&M Competencies = 99
- R&M Sub-competencies = 405
- OSD with support from DAU and Services is defining the approach
- Sources for R&M training:
  - DAU
  - Services
  - Academia

Learning architecture supports capability and career growth for the DoD R&M Engineering Workforce

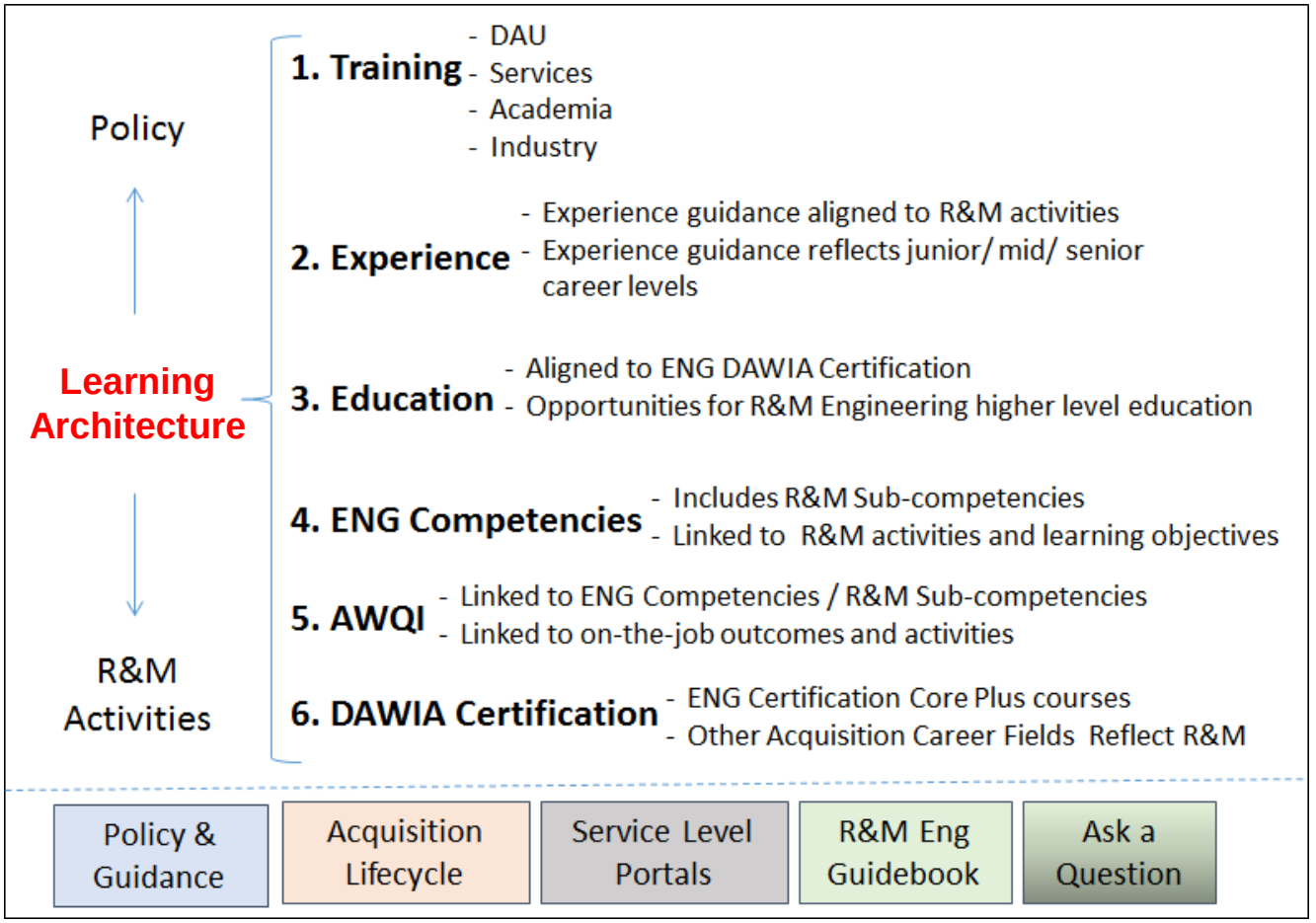
Instantiating the R&M Engineering BoK
R&M Engineering CoP Overview

- **Objective of the R&M Engineering Community of Practice (CoP) - to provide the DoD R&M Engineer a user-friendly integrated reference source for**
  - R&M Engineering Technical Information on specific topics
  - R&M Engineering Career Development
  - R&M Engineering General Knowledge
- **Emphasis on R&M Engineering relevant information, but more global topics such as Cost Estimating, Contracting, etc. can be addressed by inserting links to relevant DoD sites**
- **R&M CoP to be hosted from DAU's new Sharepoint interactive platform**
- **Membership / access levels to content planned to be controlled by DAU via CAC credentials**
  - Government (Phase 1)
  - Government Support Contractor
  - DoD Contractors
  - Industry / Open

Learning Architecture Integration Within the R&M CoP

- ***Example: the R&M Engineer has clicked on the "Learning Architecture" term to bring up more detailed information ….***

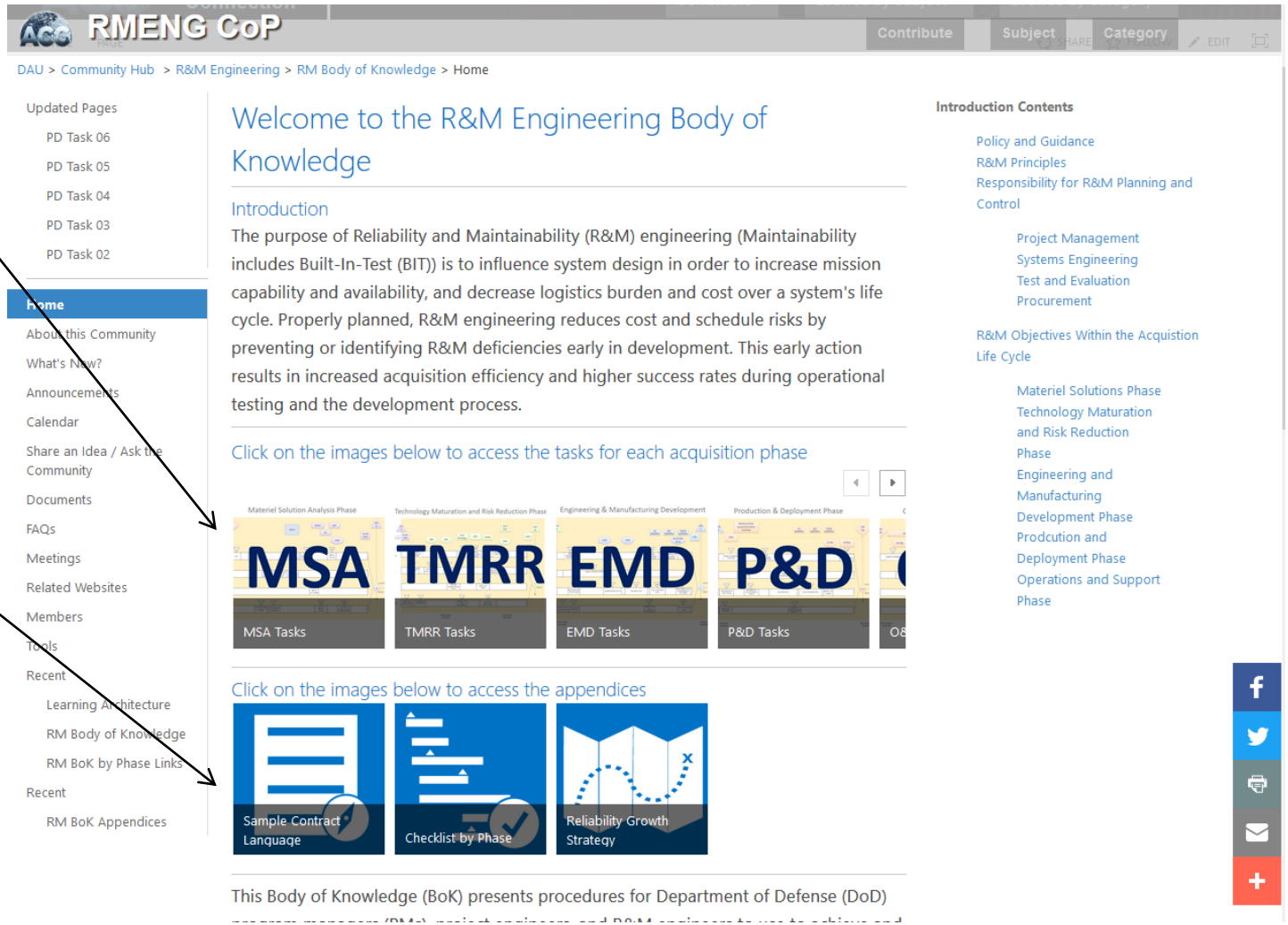
- The Learning Architecture forms a "hub" of information for R&M career development
- Each of the six categories decomposes to lower levels of information detail
- Horizontal integration occurs to Policy and R&M Activities
- A variety of products, body of knowledge and tools are linked to each category within the learning architecture infrastructure
- DoD Program Management also can use the Learning Architecture to augment personnel management practices
- Interactive tiles allow for navigation to specific topics. More tiles can be added to represent additional topics



Home Page – R&M Content Example

- *… the R&M CoP Home Page starts with an interactive DoD Acquisition Lifecycle diagram*

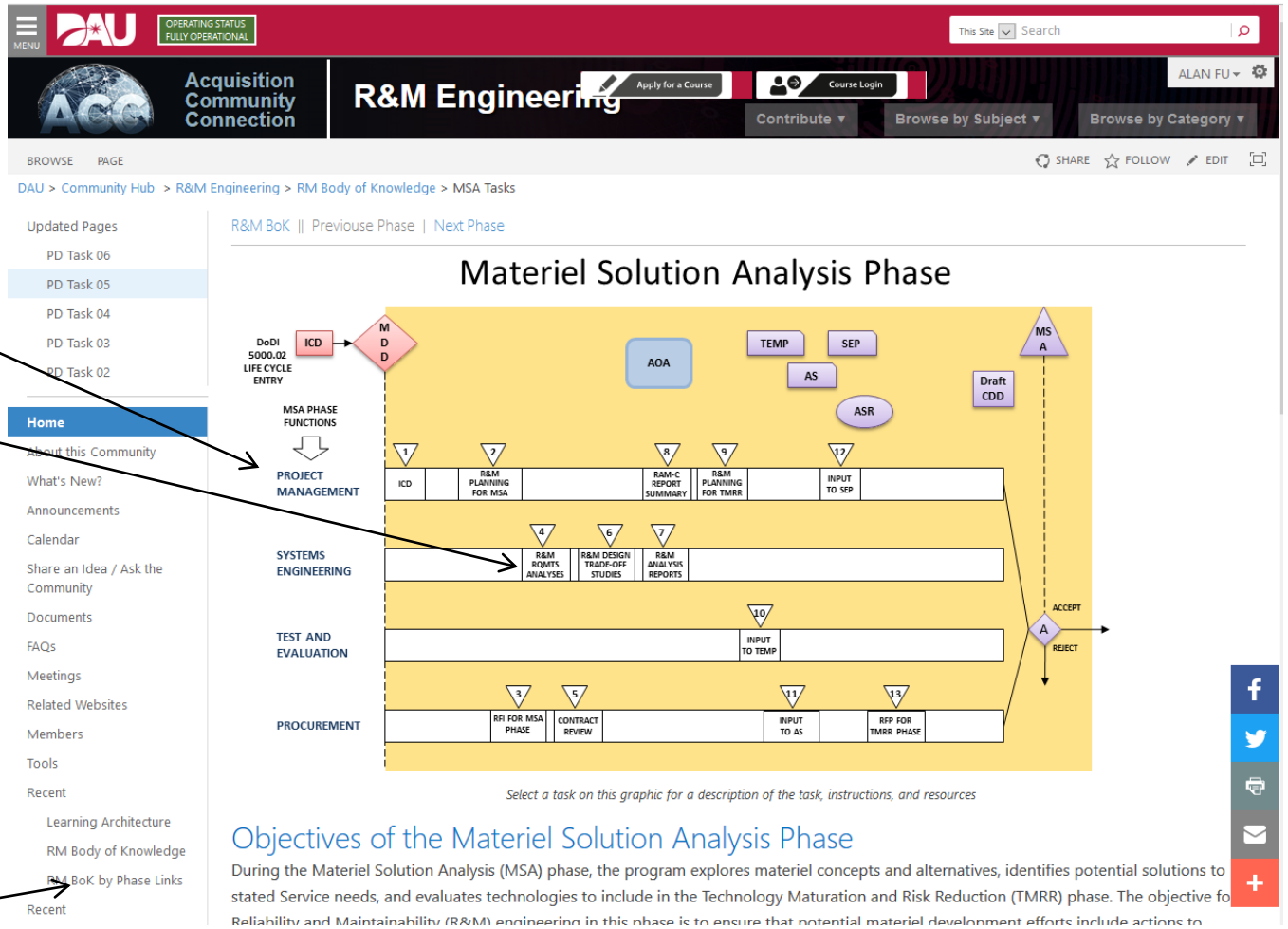
- Each DoD acquisition phase graphic may be decomposed, showing lower level R&M information for that selected acquisition phase
- Navigation "buttons" can be added to allow the R&M Engineer to easily navigate between webpages
- Other terms in the graphic may be hyperlinked to provide additional R&M related information when selected
- … this Home Page may also include interactive tiles for the R&M Engineer to directly access specific information



"Phase Level" Page Example – MSA Phase

- ***Example: the R&M Engineer has clicked on "MSA phase" and now views R&M MSA functional areas and individual activities ….***

- This graphic, from the R&M Engineering Guidebook, identifies the R&M activities for the MSA phase by functional area listed on left
- Each functional area name and individual activity names/numbers may be hyperlinked to provide further information for the R&M Engineer …
- Other terms present in the graphic may also be hyperlinked for more information
- The interactive tiles from the home page continue to be visible for the R&M Engineer to directly access specific information



Summary

- Service-level leadership engagement essential to work across centers, commands, etc.
- Define required engineering activities across the acquisition timeline for each functional area.
- Outreach is key to ensure successful implementation
- Continued refinement and assessment of execution with the Services and industry (e.g., RAMS)
- Maintain currency of the Body of Knowledge with DoD and Industry engagement

Body of Knowledge must be reactive in response to program execution to be effective

Systems Engineering: Critical to Defense Acquisition










Defense Innovation Marketplace
http://www.defenseinnovationmarketplace.mil

DASD, Systems Engineering
http://www.acq.osd.mil/se

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