NAVAL POSTGRADUATE SCHOOL

M&S Education for the Acquisition/T&E Workforce Requirements Analysis

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Overview

- Project Overview
- Observations on the requirements and the current state of the body of knowledge

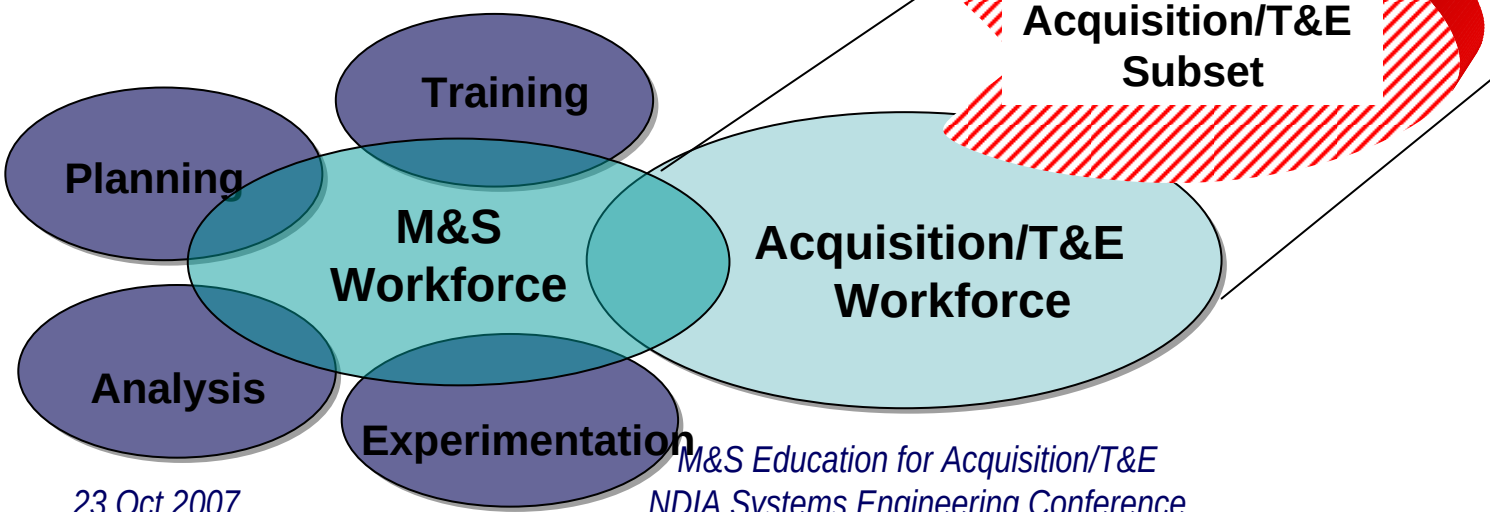
Market Segmentation

Educating the Acquisition and T&E Workforce in the More Effective Use of M&S:

Market Schema

Career Levels
Advanced/Senior
Intermediate/Journeyman
Basic/Entry

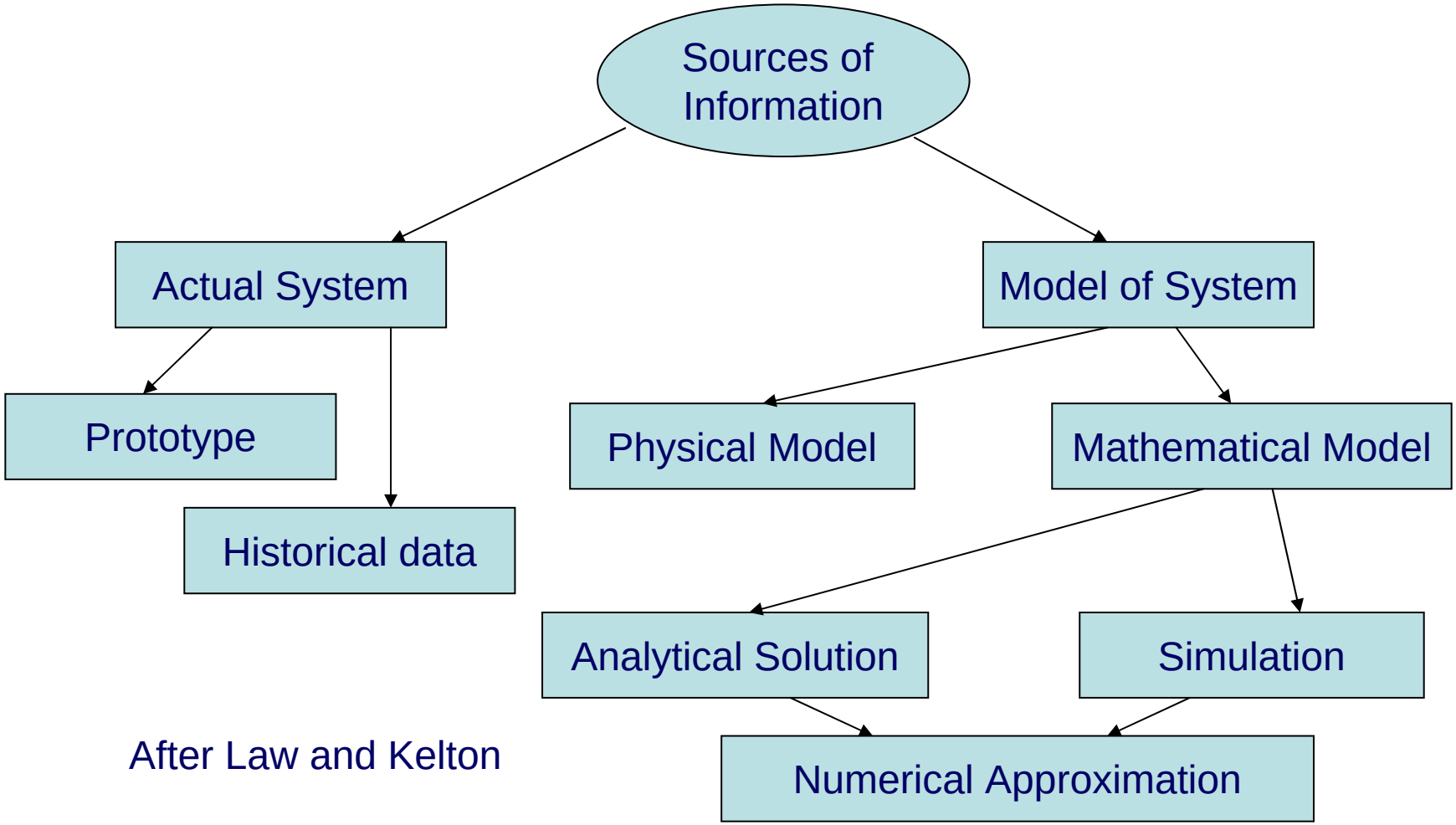
Acquisition Career Fields
Program Management
Systems Engineering
Test and Evaluation
Contracting
Logistics
Facilities Engineering
Auditing
Science & Technology
Information Technology
Business, cost estimating, and financial mgmt
Industrial and/or contract property management
Manufacturing, production and quality assurance
Purchasing



Where we are today

- Work Completed
  - DoD M&S Human Capital Strategy - COCOM visits conducted, Survey responses being collected
  - Consolidated BOK - Drafted, feedback received from all but 1 community
  - Learning Matrix – Draft Complete
    - Educational catalog delivered
    - ESRs developed
    - Initial gap analysis complete
    - Academic partners identified and participating (GMU, JHU/APL, ODU, UAH, UCF, and UCSD)
- Near Term Activities – Through December 2007
  - Complete Spiral One
    - Incorporate Stakeholder feedback to Learning Matrix (10 October)
    - Shaping Meeting (10 October)
    - BoK/HCS completion (expected completion 1 Dec)
  - Spiral Two: Learning Architecture/Instructional Framework Development
    - Develop module/syllabi framework based on learning matrix
- FY08 Funding will enable development of education and evaluation program

Overall Approach: Information Trade Space



After Law and Kelton

High Level ESR Development

- Process:
  - Initial list of ESR's developed by stakeholders and NPS inter-disciplinary team.
  - Stakeholders involved in iterative process to expand and refine ESR's to current list.
- Results:
  - 17 Process ESR's –Focused on the process of choosing when to use which models and simulations.
  - 9 Acquisition ESR's –Focused on applying M&S in the acquisition lifecycle.
  - 5 Test and Evaluation ESR's –Focused on the role and use of M&S in test and evaluation.
  - 5 Operational ESR's –Focused on the use of operational and logistic M&S to support Acquisition/T&E activities.
  - 14 Engineering ESR's –Focused on the use of engineering models to support Acquisition/T&E activities.

Note: High Level ESR's listed in backup slides.

Workforce Mapping

- Mapping of ESRs to workforce needs (Learning Matrix)
- Performed by Academic Partners, including GMU, JHU/APL, ODU, UAH, UCF, and UCSD
- Three pieces provided to complete mapping:
  - Workforce segmentation definitions
    - Career Fields - Project Managers, Systems Engineers, and T&E workforce
    - Career Levels - Basic/entry, intermediate/journeyman, and advanced/senior career levels
    - Follows DoD 5000.52M descriptions
  - Competence Levels
    - Four competence levels defined and mapped to Bloom's taxonomy – General Awareness, Understand, Application, and Mastery
  - Detailed ESR's – High level ESR's decomposed into "mappable" level of granularity

Note: Career field/level descriptions and competence level descriptions provided in backup slides.

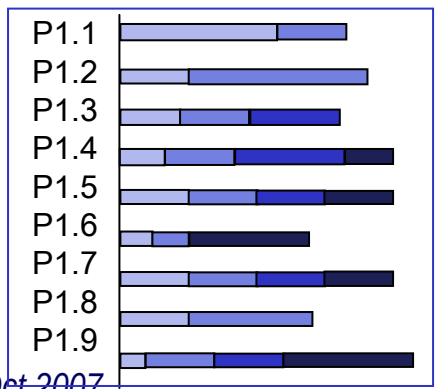
Workforce Mapping Example
Learning Matrix for one ESR (of 50)

	P13: Understand the trades between using a general model and a custom model, including the VV&A implications.								
	P13.1	P13.2	P13.3	P13.4	P13.5	P13.6	P13.7	P13.8	P13.9
PM									
Basic	General Awareness	General Awareness	General Awareness	General Awareness	General Awareness	General Awareness	General Awareness	General Awareness	General Awareness
Intermediate	Understand	Application	Application	Application	Application	Application	Application	Mastery	Mastery
Advanced	Understand	Understand	Understand	Understand	Understand	Understand	Understand	Understand	Understand
SE									
Basic	Understand	Understand	Understand	Understand	Understand	Understand	Understand	Understand	Understand
Intermediate	Understand	Application	Application	Applica					
Advanced	Understand	Application	Application	Applica					
T&E									
Basic	Understand	Understand	Understand	Unders					
Intermediate	Understand	Application	Application	Applica					
Advanced	Understand	Application	Application	Applica					

P13.1 Define general model and custom model
P13.2 State advantages of general model
P13.3 State disadvantages of general model
P13.4 State advantages of custom model
P13.5 State disadvantages of custom model
P13.6 State VVA requirements of general model
P13.7 State VVA requirements of custom model
P13.8 Describe situations where each type of model is more appropriate
P13.9 Given historical examples of each, describe and analyze which is more appropriate

Current work (complete Dec 07)

- Goal – Develop Course/Module "Syllabi"
  - Syllabi outline desired content of educational elements that will satisfy the needs identified in the Learning Matrix.
  - Syllabi combined into a consolidated and cohesive Learning Architecture.
- Each module developed to highest level of competency required for the subject matter (not always mastery)
- Modules constructed so that slices of the content can be extracted for lower required competency levels



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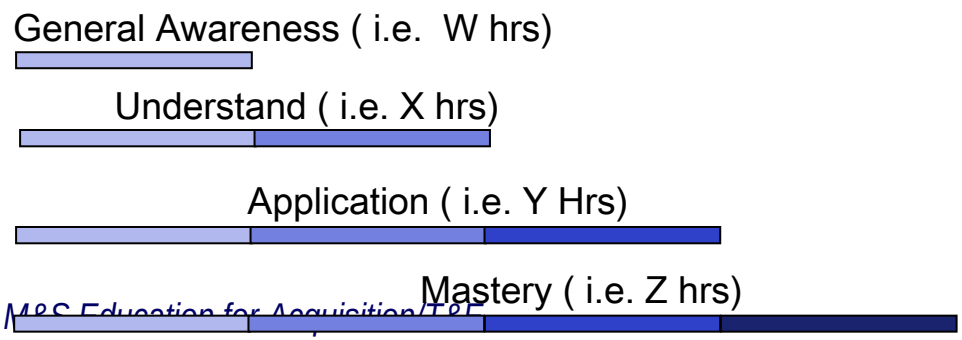

Next phase

- Courses built to target audience
  - Desired length of courses and competency levels required determine subset of modules combined into course structure
  - Human Capital Strategy survey feedback will help guide requirements.
- Courses tested

Academic Partners

- Air Force Institute of Technology
- Defense Acquisition University
* George Mason University
* Johns Hopkins University/ Applied Physics Lab
* Old Dominion University
- Stevens Institute
- Texas A&M
* University of Alabama, Huntsville
* University of California, San Diego
* University of Central Florida

Process

P1) Understand the critical decisions in the acquisition lifecycle, the analysis plans to support them, and the information required.

P2) Understand the role of modeling and simulation prior to the concept decision to identify and quantify capability gaps and to estimate how well new program concepts might address those gaps.

P3) Understand the costs, benefits, and risks of using physical testing, modeling and simulation, and historical data to provide information for acquisition decisions.

P4) Know the technical aspects of the domain of application.

P5) Know the taxonomy and hierarchies of models and simulations and be able to select appropriately for a given situation. Understand the types of architectures and role of architectures in tying together and communicating requirements, analysis, modeling and simulation, design, and development planning to all stakeholders. Understand how M&S is deployed in different environments (Live, Virtual, and Constructive). Understand the differences between standalone and confederated M&S applications and when to apply each in various situations. Be familiar with the simulation interoperability standards.

Process

P6) Establish and write valid modeling and simulation requirements using a process that includes modeling and simulation needs analysis, generation of valid modeling and simulation requirements, functional decomposition and conceptual model development, and issuance of "built to" or "buy to" performance specifications. Understand how models and simulations evolve in fidelity, resolution, and scope as the program life cycle progresses.

P7) Estimate the cost, develop a schedule, and measure the performance of a modeling and simulation plan. Identify the areas of risk and develop a mitigation strategy.

P8) Know how to incorporate modeling and simulation, through a Simulation Support Plan, into a systems engineering plan and a test and evaluation master plan.

P9) Know and require the best practices and standards in modeling and simulation as developed in key case studies.

P10) Know the models and simulations used in a given domain, their inputs and outputs, and their strengths and weaknesses.

Process

P11) Know the common terminology and high level roles and responsibilities, as well as the underlying philosophy, principles, and methodologies used in VV&A efforts, especially those applied in DoD.

P12) Be able to correctly match the level of detail of a model with that of the information needed to support a decision, and understand the connection between the decision to be made and the estimation of measures from the model.

P13) Understand the trades between using a general model and a custom model, including the VV&A implications.

P14) Design a sound simulation study for a given set of objectives.

P15) Apply appropriate statistical techniques to the analysis of simulation output.

P16) Know how to manage and reuse existing models, data, and simulations appropriately and assure that new products developed are designed and prepared for reuse.

P17) Manage the data strategy for an M&S effort including estimating the resources necessary to obtain sufficient data to populate the model.

Acquisition

A1) Understand the types, role and value of formal Modeling and Simulations, and their various characterizations for application to systems management, particularly with regard to design, testing, training, production, cost estimation, manning, and logistical simulations.

A2) Understand the concepts of Simulation-Based Acquisition (SBA) across the entire program life cycle, in order to reduce the time, resources, and risks associated with the acquisition process.

A3) Be able to discern among M&S proposals, relative to measurable program contributions, and decide on the appropriate program office level of expenditure on M&S tools throughout the program life cycle. Distinguish whether custom or off-the-shelf products will be best suited for the program's purpose.

A4) Understand the role of M&S in the contract proposal process, how M&S efforts will be defined and specified, and the value of M&S deliverables under an acquisition contract. Determine their need for continuous improvement, vis-à-vis M&S cost/benefit trades throughout the program life cycle.

Acquisition

A5) Know where to find organizational M&S resources to identify the number and types of models currently in use, best practices from case studies, where they originated, how they might be leveraged in support of an acquisition program.

A6) Be aware of the Modeling and Simulation Resource Repository as a single source for information about and access to DoD models, simulations, data sources, algorithms, and other M&S resources in order to facilitate reuse and avoid duplication.

A7) Understand experimental design, level of model detail, and M&S application as a pre-test prediction tool. Use M&S to make informed engineering tradeoff analyses through the program's Decision Risk Analysis process. Understand the analysis of M&S outputs/measures.

A8) Understand the critical interrelationships and balance between modeling and simulation and more traditional forms of test and evaluation (T&E) – particularly operational and live-fire test and evaluation.

A9) Know how to employ M&S to explore reliability and interoperability issues.

Test and Evaluation

T1) Quantify the risk of using M&S in place of live testing. For open systems, quantify the risk of using M&S to evaluate a single system component in place of testing an entire configuration.

T2) Integrate M&S, live test, prototype data, historical data, component data, and scale model data into a coherent testing decision.

T3) Understand the different types of testing (i.e. unit, integration, interoperability, and operational) and identify the utility, limitations and risks for use of M&S in each.

T4) Understand the potential opportunities for employing M&S in the test planning and execution process.

T5) Be aware of existing M&S T&E facilities used within the DoD.

Operational/Logistics

O1) Understand the role of operational and logistical models in the acquisition life cycle and when they are used.

O2) Know the properties of a representative suite of operational models across the services.

- Required inputs, Outputs, Assumptions, Implementation requirements, Costs, Time required, Adaptability and extensibility, VVA status

O3) Know the properties of a representative suite of logistical models across the services.

- Required inputs, Outputs, Assumptions, Implementation requirements, Costs, Time required, Adaptability and extensibility, VVA status

O4) Understand abstractions and lower levels of realism in operational and logistics models.

O5) Understand and be able to model the components of logistics systems, including Supply Chain, Storage systems, Facilities, Production, Inventory management, Transportation & distribution, Replenishment policies

Engineering/Technology

E1) Structural Mechanics, Shock and Vibrations - Understand basic structural mechanics including stress-strain relations, buckling and fatigue, shock and vibration, and finite element methods in M&S.

E2) Fluid Dynamics and Weapon System - Understand the basics of computational fluid dynamics for CFD application and use for M&S. Fluid dynamics of subsonic and supersonic weapons, warheads and their effects.

E3) Dynamics and Control - Understand the basics of M&S in process and multi-physics (mechanical, electrical & hydraulic) based dynamic system controls.

E4) Thermodynamics and Heat Transfer - Understand the fundamentals of thermodynamics and heat transfer with applications to M&S in engineering power cycles, propulsion and auxiliary system cycle analysis and design.

E5) Materials and Fabrication - Possess a basic understanding of the materials technology associated with manufacturing, welding and corrosion control. Have an introduction to composite, superconducting materials, and fiber optics as applied to M&S.

Engineering/Technology

E6) Acoustic and Electromagnetic Systems - Have a general awareness of the fundamentals of acoustic and electromagnetic wave propagation and application to DoD systems.

E7) Military Platform Systems Engineering - Appreciate the broad-based design oriented M&S approach for complex platforms that interact with air-land-sea-based hardware systems, command and control systems and combat systems.

E8) Computers - Recognize basic computer system architecture, operating systems, networking and introduction to engineering software and their applications. Have an introduction to structured programming languages such as Fortran and C, and the use of such tools for code development. Gain exposure to finite element/difference codes, with application to solve engineering problems including experience with selected software packages.

E9) Electrical Engineering - Understand basic circuit analysis including DC and AC circuits. Gain an exposure to the construction and operating characteristics of rotating machinery, static converters, power distribution systems and multi-phased circuits.

Engineering/Technology

E10) C4ISR - Value the requirement for C4ISR in systems. Understand the basic components, methods and alternatives for transferring information from one point to another both internal and external to the system being considered. Have the ability to analyze all available technologies for achieving rapid/effective/jam-resistant information transfer.

E11) Networks – Understand the principles of networks applied to military applications including physical, command and control, and social networks and their implications for engineering design of systems.

E12) Environment – Understand the fundamentals of terrestrial science (geology, oceanography, meteorology, and near-earth space science) to describe how systems interact with and are influenced by their environment.

E13) Human Systems Integration – Understand the principles of Human Systems Integration. Describe the applications of M&S to support HSI design and analysis.

E14) Aerodynamics – Understand the principles of aerodynamics with applications to M&S. Understand the cost, schedule, and iterative development nature of simulation testbeds used for flight software development through formal qualification.

Conclusions

Backup

Program Management Career Field

(from DoD 5000.52M)

- Positions Held:
  - All of functions of a PMO or PEO
  - Program integrators and analysts, program managers, PEOs, and deputies
  - Support and management positions throughout the workforce
- Responsibilities:
  - Balance the factors that influence cost, schedule, and performance
  - Interpret and tailor application of the DoD 5000 Series regulations
  - Ensure that high-quality, affordable, supportable, and effective defense systems are delivered to the warfighter as quickly as possible

PM Career Levels

- Basic/Entry
  - Member working in PM support role
  - Example jobs include R&D coordinator, test officer staff officer, integrator, analyst, etc.
- Intermediate/Journeyman
  - Managers of PEO/PMO office functions
  - Deputy PM or PM for small programs, PEO staff roles
- Advanced/Senior
  - ACAT 1 or 2 PM, PEO

SPRDE – Systems Engineering Career Field (from DoD 5000.52M)

- Positions Held:
  - Scientists and engineers supporting science and technology and acquisition programs, projects, or activities to accomplish the responsibilities below
- Responsibilities:
  - Planning, organizing, monitoring, managing, overseeing and/or performing research and engineering activities relating to the design, development, fabrication, installation, modification, sustainment, or analysis of systems or systems components

SE Career Levels

- Basic/Entry
  - Design, development, fabrication, installation, modification, sustainment, or analysis of systems or systems components
  - Workforce executing these tasks across a broad range of application domains
- Intermediate/Journeyman
  - Managers of teams working on application level functions
  - Line managers at warfare centers, project leads for R&D projects
- Advanced/Senior
  - CHENG, Warfare center execs, project systems engineers

Test and Evaluation Career Field

(from DoD 5000.52M)

- Positions Held:
  - T&E team members; T&E leads for programs; Service, Agency, and Facility T&E managers, engineers, scientists, operations research analysts, system analysts, computer scientists; other technical personnel who plan, perform, and manage T&E tasks in support of acquisition
- Responsibilities:
  - Plan, monitor, manage, and conduct T&E of prototype, new, fielded, or modified C4ISR and weapon or automated information systems, equipment or material
  - Analyze, assess, and evaluate test data and results and prepare assessments of system performance and reports of T&E findings

T&E Career Levels

- Basic/Entry
  - Test planning, execution, and analysis functions performed for DT and OT, including interoperability and other certification testing requirements
  - Includes testing in Live, Virtual and Constructive environments
  - Workforce executing these tasks across a broad range of application domains
- Intermediate/Journeyman
  - Managers of testing activities
  - T&E agency team leads, Project T&E managers
- Advanced/Senior
  - Testing activity executives, PMs, Milestone decision authorities

Competence Levels

Competence Level	Bloom's Taxonomy	Definition	Examples and Keywords
General Awareness	Knowledge	Recall or recognize data or information.	**Examples:** Recite a policy. Quote prices from memory to a customer. Knows the safety rules. **Keywords:** defines, describes, identifies, knows, labels, lists, matches, names, outlines, recalls, recognizes, reproduces, selects, states.
Understand	Comprehension	Understand the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words.	**Examples:** Rewrites the principles of test writing. Explain in one's own words the steps for performing a complex task. Translates an equation into a computer spreadsheet. **Keywords:** comprehends, converts, defends, distinguishes, estimates, explains, extends, generalizes, gives Examples, infers, interprets, paraphrases, predicts, rewrites, summarizes, translates.
Application	Application	Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the work place. Put theory into practice, use knowledge in response to real circumstances	**Examples:** Use a manual to calculate an employee's vacation time. Apply laws of statistics to evaluate the reliability of a written test. **Keywords:** applies, changes, computes, constructs, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses.

References:
http://www.nwlink.com/~donclark/hrd/bloom.html
http://facultywashington.edu/krumme/guides/bloom1.html
http://www.businessballs.com/bloomstaxonomyoflearningdomains.htm

Competence Levels

Competence Level	Bloom's Taxonomy	Definition	Examples and Keywords
Mastery	Analysis	Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.	**Examples:** Troubleshoot a piece of equipment by using logical deduction. Recognize logical fallacies in reasoning. Gathers information from a department and selects the required tasks for training. **Keywords:** analyzes, breaks down, compares, contrasts, diagrams, deconstructs, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, relates, selects, separates.
	Synthesis	Builds/develops new structures, systems, models, approaches, or patterns from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.	**Examples:** Write a company operations or process manual. Design a machine to perform a specific task. Integrates training from several sources to solve a problem. Revises and process to improve the outcome. **Keywords:** categorizes, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes.
	Evaluation	Make judgments about the value of ideas or materials. Assess effectiveness of whole concepts in relation to values, outputs, efficacy, viability; critical thinking, strategic comparison and review.	**Examples:** Select the most effective solution. Hire the most qualified candidate. Explain and justify a new budget. **Keywords:** appraises, compares, concludes, contrasts, criticizes, critiques, defends, describes, discriminates, evaluates, explains, interprets, justifies, relates, summarizes, supports.

References:
http://www.nwlink.com/~donclark/hrd/bloom.html
http://faculty.washington.edu/krumme/guides/bloom1.html
http://www.businessballs.com/bloomstaxonomyoflearningdomains.htm