DRAFT

OPERATIONAL CONCEPT

FOR

THE FUNCTIONAL BAND PROCESS

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US Army Simulation, Training and Instrumentation Command (STRICOM) Functional Band Implementation Team

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Draft

Operational Concept for the Functional Band Process

1. Functional Band Concept.

The Functional Band Implementation Team was created to implement the recommendations made by the COD team. The team reviewed the overall concept and made some minor modifications to their recommendations. We are presenting in the paragraphs below the general structure of a recommended Functional Band.

The functional band will be used to develop and maintain corporate knowledge. It will provide STRICOM Engineering with a defined list of skills within each functional band. Training can be prioritized so that it will be concentrated on building the skills important to the organization. The Functional Band Implementation Team substituted the terminology of "Sub-bands" with "areas of expertise" (e.g. different domains) identified within each of the functional bands.

The functional band structure will be the key for any future engineering support to any of our external or internal customers. It will provide training in the skills required to support present and future programs, provide tools for resources forecast, and to provide for Horizontal Technical Integration (HTI) and professional development. The functional band list of required skills, and their definitions, could be used so that expertise not available within STRICOM could be obtained from other Government organizations and/or contractors.

1.1 Definition.

A Functional Band is defined as a logical grouping of engineers with similar skills and job performance requirements. Functional bands are defined by identifying common and existing areas of interest, significant engineering presence, and/or emerging engineering domains utilized by STRICOM Engineering. Employees belonging to a band would perform similar functions, but not necessarily in the same Division. These employees would perform as a team to improve the effectiveness of the functional area of their expertise. Figure 1 pictorially depicts the proposed operational concept for functional bands indicated above. Key benefits of the functional band are to:

- provide guidance and mentoring for the development of band engineers to develop/enhance technical expertise,
- promote HTI, share information and lessons learned,
- maintain state of the art and identify technology trends,
- identify and participate in training opportunities relating to their areas of expertise,
- provide the STRICOM Engineering leadership with the ability to maintain and/or develop the required skills to support the needs of our customer
- facilitate cross training opportunities to provide for professional development since criteria for each functional band is defined
- identify education and experience necessary for an individual to maintain and/or improve levels of expertise within each functional band

The functional band concept provides for 4 bands, each band will have a common set of skills and band specific skill(s) pertaining to each band. A developmental path associated with each band provides defined objectives to develop professional skills associated with that band; and sustaining skills to maintain expertise. Additionally, this will provide a predefined path of basic skills that shall be demonstrated prior to transition to another band or prior to be certified to a higher level of expertise within that band.

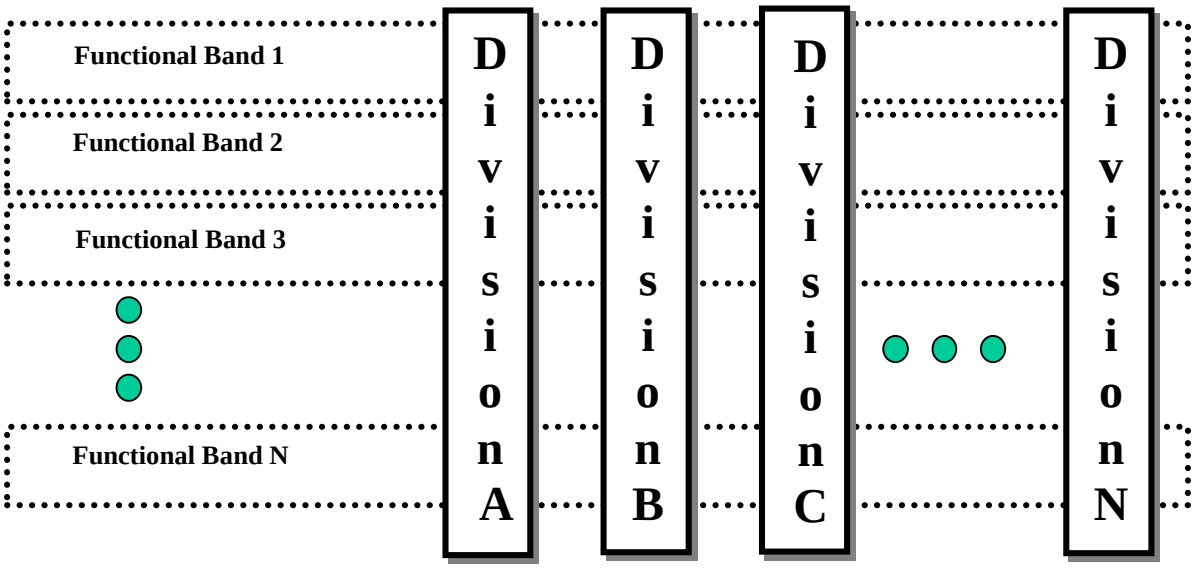


Figure 1. Proposed Operational Concept for Functional Bands

1.2 Mobility Across Bands

Mobility across bands is necessary in order to augment band resources and provide for professional development. A transition process to move across bands is described below to facilitate mobility and to provide a road map for all engineers.

Specific skills/knowledge (see section 2) is required for each band at various levels. Specific band entry or basic skill requirements of a particular band need to be demonstrated in order to assign or certify an engineer to the requested band. The entry/basic skills should be acquired (e.g. training, experience) prior to being accepted in the subject band.

An engineer who desires to move into a band will provide a memorandum explaining his/her desire and will provide information pertaining to his/her training and experience to meet the basic skills. A board composed of the gaining functional team leader and the applicant's supervisor should evaluate the applicant's request to move into a band.

The transitional engineer IDP should be updated to incorporate the new developmental path.

1.3 Continuous Improvement

Continuous evaluation of the functional band process is necessary to assess the effectiveness of the current functional band structure and determine changes if necessary. This evaluation should consist of the overall band structure as well as internal functioning (skill level, technology areas) within each band.

A Functional Band Continuous Improvement Team (FBCIT) should have, as a minimum, the functional band team leader and at least one member of the Leadership team. The team should meet as required (e.g. quarterly or strategic planning session), but at least once a year, to discuss evolution of the technical skills, training, and any other issue pertaining to the functional band structure.

1.3.1 Metrics

The metrics to be collected must support the FBCIT in the evaluation of the overall band structure as well as internal functioning (skill level, technology areas) within each band. In addition, it must consider the Customer (Outside) perspective of the E Directorate to ensure we are successfully satisfying the Customers requirements.

Therefore we are classifying the metrics into the following two areas:

- Functional Band Structure & Processes:

    1. Customer survey and employee database to ensure that the E Directorate is provided proper education to engineers.
    2. Use employee database for tracking education advancements within E Directorate and mobility of engineers across bands.
    3. Matrix for tracking industrial technological advancements and how it relates to E Directorate.
    4. Utilize employee yearly survey to evaluate the functional band processes.

- Customer Satisfaction:

    1. Customer survey to ensure that the E Directorate provided the proper mix of engineering disciplines.
    2. Customer and Supervisor survey to evaluate quality of engineering support.

1.4 Functional Band Team Leader

Functional Band Team Leaders (FBTL) need to be recognized as experts by their peers, be able to act as mentors, and possess leadership capabilities. They will be key instruments in propagating HTI across the bands. They will work with E Directorate Supervisors to assist the employees in meeting their career growth goals while providing the E Directory required technical skills.

The FBTL will report directly to the Leadership Team and the period of performance will be twelve months. This will ensure that a FBTL will be in place for one complete review cycle. The FBTL will have the necessary authority to perform the required tasks (either working level or supervisor engineers could be considered). A minimum of one FBTL will be assigned per functional band.

The FBTL will:

- provide training, guidance, and mentoring for the development of their respective functional band engineers.
- keep their functional band peers informed on new technologies.
- identify training needs to ensure required skills are available within their functional band.
- ensure that standard practices, processes, and policies are applied within the respective functional band.
- ensure that an Individual Development Plan is in line with the needs of the functional band.
- manage the HTI across divisions in accordance with the Operational Concept for HTI. The FBTL will present to the leadership team, for their approval, the number of focus areas to be selected. The FBTL will monitor assigned engineer(s)/working groups to evaluate new requirements, enabling technologies, and other focus areas.
- responsible for cross-fertilization of technologies. The FBTL will interface with the responsible Engineer or the PM/DPM to help determine which projects or areas could leverage off existing or promising technologies.
- responsible for the implementation of product line engineering.
- evaluate/approve required functional band skills for existing and new applicant's requesting to move into the functional band.
- provide and update appropriate certification metrics to be used to evaluate different levels of expertise within that functional band

1.4.1 Criteria for Functional Band Team Leader Selection

The E Directorate Leadership Team will nominate three candidates for the FBTL position once a year. The members of the functional band will vote on these candidates to select the FBTL. The FBTL should be recognized as role models of the functional band and possesses knowledge of core specialties relating to the functional band.

1.4.2 Individual Skill Level Expertise

The FBTL will assign a point of contact for each skill identified in the Operational Concept for the Functional Band Process. The skill POC will be responsible to maintain the skill information, as required provided in that document (as an appendix). The POC will initialize and maintain the database with the skills level for each member of his functional band. The skill levels will range from 1 to 7 and will serve as a metric to indicate individual expertise as it pertains to each particular skill. The following point scheme will be utilized to initialize the database created by the Workload Management Implementation Team:

- Point for each continuing education course (must be specific to Skill area), such as DAWI Course, UCF Course, Graduate courses, etc.
- Developmental assignments to other commands/directorates performing work related to the skill
- Advance Degree
- 1 point for every 2 years experience related to the skill

2. Categories of Functional Bands

The Functional Band Implementation Team has identified and recommended four functional bands: Program Engineering, Software Engineering, Synthetic Engineering, and Principal Investigator.

2.1 Program Engineering

Provides a focused approach for development of a system or product. Performs the role of integrating the technical disciplines to achieve the customer's objectives. Program Engineering includes resource planning, system architecture analysis and design, system planning, system integration, test and evaluation, and sustainment. This band includes the previously COD described 'integration' engineering to focus on the integration across a simulation product line.

2.2 Software Engineering

Provides expertise for presently used software engineering processes and methodologies (requirements analysis, design, coding, and test); software management (risk assessment and control, planning, cost estimating, metrics, progress tracking); knowledge of currently used software programming languages (i.e. Ada 95, C++, Java); knowledge of HLA standards; software quality; software configuration management.

2.3 Synthetic Engineering

Focus on the integration of requirements for visual engineering, Computer Generated Forces (CGF) engineering, and simulation architecture engineering. Maintain up-to-date technical information on specialty topics. Develop application and design standards for technical issues like synthetic environments, interoperability, embedded simulation, virtual reality, symbolic processing, discrete systems simulation, Natural Language processing such as neural nets, artificial intelligence and Expert systems.

2.4 Principal Investigator

Is responsible for technology development. While responsible for programmatic issues related to technology development, the primary requirement is for technical expertise in a given domain. A PI is responsible for concept development, execution and transition. Transition both from sources of research and transition to program managers for product development. Must have established a relationship and transition path with respective Program Managers. Maintain up-to-date technical information on specific domains. Be able to apply and develop advanced technologies like synthetic environments, interoperability, embedded simulation, virtual reality, symbolic processing, discrete systems simulation, Natural Language processing such as neural nets, artificial intelligence, decision making, CGF, augmented reality, Expert systems and other emerging technologies that support STRICOM's mission.

3. Functional Bands Skills

A description/definition of the common skills and the tasks/effort required during the application of these skills are provided. In addition, the basic skills, training and/or work assignments/experience that will aid the individuals in the development of these skills and the path required to achieve proficiency in these skills are provided. Figure 2 shows the relationship of the skills in the functional bands concept.

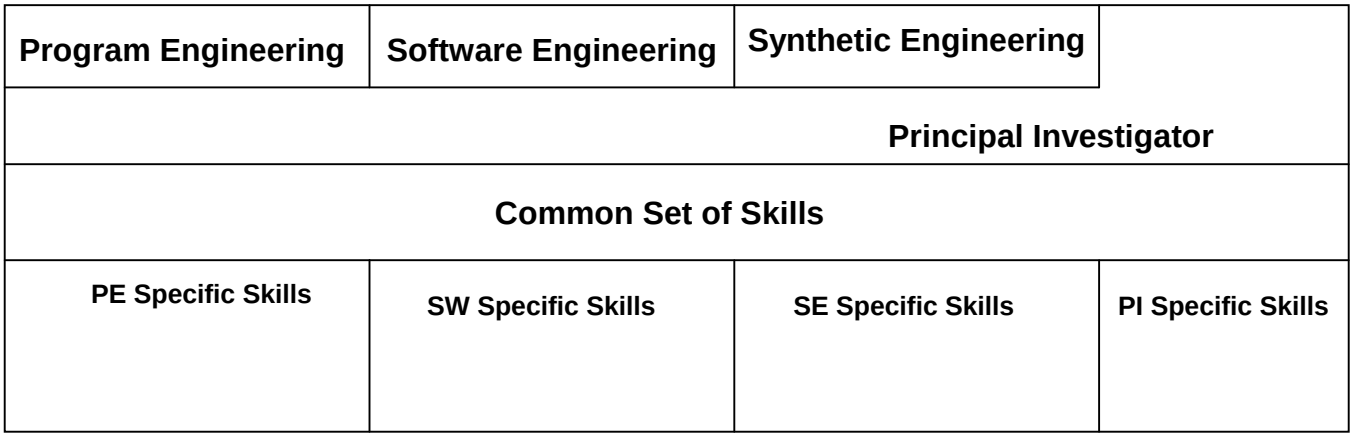


Figure 2. Relationship between Functional Bands and Skills

3.1 Common Skills

These are the common set of skills that are required by all bands as STRICOM engineers.

Functional Bands Common Skills:	Appendix Page:
Acquisition Planning & Process	A-1
Advance Technology Assessment	A-2
Communication (Oral & Written)	A-3
Computer Engineering (integrated HW/SW)	A-4
Concept Formulation	A-6
Configuration Management	A-7
Contractor Monitoring	A-8
Cost Estimation	A-9

Functional Bands Common Skills:	Appendix Page:
Domain (Product) Engineering (Analysis, Architecture, Modeling & Implementation)	A-10
Feasibility Analysis	A-11
Functional Analysis/Allocation	A-12
Human Factors Engineering (HFE)	A-14
Interoperability (including DIS, DIS++, ALSP, HLA)	A-15
Management of Technical Data (Data Management)	A-17
Market Surveys/Trade Studies	A-18
Process Engineering	A-20
Quality Assurance (QA)(Hardware and Software)	A-25
Requirements Analysis and Development	A-27
Risk Management (Technical(performance related), Supportability(performance related), Programmatic (environment related), Cost, and Schedule)	A-28
Safety Engineering	A-30
Soliciting, Evaluating, Negotiating, Debriefing, and Awarding Proposals	A-32
Technical Architecture (Army/Joint)	A-33
Value Engineering	A-34
Verification, Validation and Accreditation (VV&A)	A-35

3.2 Specific Skills

Band specific skills pertaining to each band. A developmental path associated for each band provides defined objectives to develop professional skills associated with that band; and sustaining skills to maintain expertise. Additionally, this will provide a predefined path of basic skills that shall be demonstrated prior to transition to another band.

3.2.1 Program Engineering Specific Skills

Program Engineering Specific Skills:	Appendix Page:
Analysis of Drawings	B-1
Audio System Design	B-2
Command, Control, Communication, Computers and Intelligence (C4I)	B-3
Domain (Product) Engineering (Analysis, Architecture, Modeling & Implementation)	B-4
Electromagnetic Environmental Effects (E3) Engineering	B-5
Environmental Engineering	B-7
Facilities Engineering	B-8
Hardware Configuration Management	B-9
High Level Architecture (HLA)	B-10
Lasers/Optics	B-11
Network Communications Engineering	B-12
Post Deployment Systems Support (HW and SW)	B-13
Production/Producibility Engineering	B-16
Program Engineering	B-18
Quality Assurance	A-25
Radio Frequency (RF) Communications Engineering	B-19
Reliability, Availability, and Maintainability (RAM) Engineering	B-20
Risk Management	B-21
Safety Engineering	A-28
System Architecture	B-23
System Engineering	B-24
System Test and Evaluation	B-25
Systems Integration	B-28
Verification, Validation and Accreditation (VV&A)	A-35

3.2.2 Software Engineering Specific Skills

Software Engineering Specific Skills:	Appendix Page:
Command, Control, Communications, Computers and intelligence (C4I)	B-3
Network Communication Engineering	B-12
Object Oriented Technology	C-1
Operating Systems	C-2
Post Deployment Systems Support (HW and SW)	B-13
Programming Languages	C-4
Software Architecture	C-6
Software Configuration Management	C-9
Software Cost Estimation	C-10
Software Development and Support Process	C-12
Software Development Methods and Tools	C-15
Software Measurements and Analysis	C-17
Software Quality Assurance	C-20
Software Requirements Analysis	C-22
Software Resource Estimation	C-24
Software Test Engineering Methods	C-26
Trusted Software Development Methodology	C-27

3.2.3 Synthetic Engineering Specific Skills

Synthetic Engineering Specific Skills:	Appendix Page:
Artificial Intelligence/Expert Sytems	D-1 and D-2
Atmospheric/Oceanographic Representation	D-3
Behavior Modeling (Intelligent Agent techniques, reactive, cognitive behavior, learning algorithms, etc…)	D-4
Computer Generated Force Applications	D-5
Display Systems	D-6
Embedded Simulation	D-7
High Level Architecture (HLA)	B-10
Multi-resolution Modeling (i.e. Fundamentals, modeling process, etc…)	D-8
Physical Modeling (object & interaction, movement, sensor, engagement, communication, etc.)	D-9
Sensor Simulation/Stimulation	D-11
Synthetic Natural Environment (SNE) Representation & Interchange	D-12
Terrain Database Modeling and Representation	D-13
Verification, Validation and Accreditation (VVA)	A-35
Visual Engineer	D-14
Visual System Design	D-16

3.2.4 Principal Investigator Specific Skills

See Appendix E for specific Principal Investigator skills.

Appendix A

Functional Bands Common Skills

A.1. Common Skill: Acquisition Planning & Process

A.1.1. Description of Skill: TBD.

A.1.2. Basic/Minimum Knowledge: TBD.

A.1.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.1.4. Developmental Path: TBD.

A.1.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.1.6. Sustainment to Maintain Expertise: TBD.

A.2. Common Skill: Advance Technology Assessment

A.2.1. Description of Skill: TBD.

A.2.2. Basic/Minimum Knowledge: TBD.

A.2.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.2.4. Developmental Path: TBD.

A.2.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.2.6. Sustainment to Maintain Expertise: TBD.

A.3. Common Skill: Communication (Oral & Written)

A.3.1. Description of Skill: TBD.

A.3.2. Basic/Minimum Knowledge: TBD.

A.3.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.3.4. Developmental Path: TBD.

A.3.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.3.6. Sustainment to Maintain Expertise: TBD.

A.4. Common Skill: Computer Engineering (Integrated Hardware (HW) and Software (SW))

A.4.1. Description of Skill:

a. Architecture: Computer engineers should have a good understanding of the architectural concepts of computer hardware and software, i.e. the HW/SW building blocks, and their interrelationship, that make the computer function as a system. Computer engineers are therefore system engineers who are focused at 'computers' as their "system". This architecture knowledge would span the various computer processor (serial, parallel, multi-) design and performance tradeoffs; this knowledge would extend to the various hardware peripherals, in addition to the central processor(s), which are components of the simulator/simulation system under focus. It would also include the interface requirements (both 'intra' and 'inter') between the HW and SW building blocks or 'modules'. The incumbent should be familiar with practices for optimizing the reconfiguration, reusability and modularity of the computer system hardware, as well as techniques (e.g. caching) for protecting and apportioning processor memory.
b. Software Engineering Focus: Practical application knowledge of at least one higher ordered language is encouraged, with C/C++, Ada, or FORTRAN preferred. Experience in estimating the anticipated effort (lines of code) to develop and produce a software module is expected. The ability to evaluate a contractor's proposal to develop, document, test and manage the configuration changes of a software product, as well as the associated hardware resources, is essential. After contract award, this engineer is expected to efficiently evaluate, monitor and guide the contractor's efforts and processes toward the expected software product performance, as well as the hardware burden required to compile and process the respective 'builds' of the software product. Computer Software Configuration Item (CSCI) module interfaces and dependencies are also included within the above-mentioned architectural knowledge. Object Oriented Design and Analysis knowledge is desired. Familiarity with Computer Aided Software Engineering (CASE) tools and Software Engineering Institute metrics, waiver and certification processes is desired. Knowledge of techniques for making databases interoperable and relational is desired. The incumbent should be:

- Familiar with concepts and practices for optimizing the practical reuse and modularity of developed software.
- Knowledgeable of post deployment software support (PDSS) and independent verification/validation (IV&V) criteria and best practices
- knowledgeable of techniques to efficiently integrate and test software for new data compression algorithms and communication protocols
- capable of demonstrating the feasibility of these techniques, as new software or communication standards are recommended

c. Distributed Networking: Computer engineers should have a broad understanding of how digital information is transferred between computer systems, both in a local area network (LAN) as well as in more remote wide area network (WAN) environments. Familiarity with server/router node requirements and Internet connectivity is desired; this familiarity suggests that these engineers are knowledgeable of:

- Common Object Request Broker Architecture (CORBA)
- hypertext transfer protocol (HTTP) application
- Distributed Interactive Simulation (DIS) and High Level Architecture (HLA) concepts
- protocol data unit (PDU) structure
- Java applet application
- Defense Simulation Internet, Integrated Service(s) Digital Network (ISDN), Defense Information System Network (DISN) capabilities
- Asynchronous Transfer Mode (ATM) relaying

At the senior engineer level, the ideal candidates will have earned a BS / MS in Electrical / Systems / Computer Engineering or Computer Science and have developed a good understanding of object-oriented (OO) principles for software analysis and design (e.g., aware of concepts such as encapsulation, inheritance, and polymorphism). They should possess 3 to 5 years of software development experience (preferably in the UNIX (X-Windows) environment). Hands-on experience in higher order language applications, Web pages and / or JAVA-based Interred applications would be a plus. They should be interested in working all aspects of the software life cycle (requirements analysis, OO design,

implementation in various higher ordered languages, testing, and all associated documentation and review phases).

A.4.2. Basic/Minimum Knowledge: TBD.

A.4.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.4.4. Developmental Path: TBD.

A.4.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.4.6. Sustainment to Maintain Expertise: TBD.

A.5. Common Skill: Concept Formulation

A.5.1. Description of Skill: TBD.

A.5.2. Basic/Minimum Knowledge: TBD.

A.5.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.5.4. Developmental Path: TBD.

A.5.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.5.6. Sustainment to Maintain Expertise: TBD.

A.6. Common Skill: Configuration Management

A.6.1. Description of Skill: TBD.

A.6.2. Basic/Minimum Knowledge: TBD.

A.6.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.6.4. Developmental Path: TBD.

A.6.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.6.6. Sustainment to Maintain Expertise: TBD.

A.7. Common Skill: Contractor Monitoring

A.7.1. Description of Skill: TBD.

A.7.2. Basic/Minimum Knowledge: TBD.

A.7.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.7.4. Developmental Path: TBD.

A.7.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.7.6. Sustainment to Maintain Expertise: TBD.

A.8. Common Skill: Cost Estimation

A.8.1. Description of Skill: The act of developing, analyzing, and documenting cost estimates using analytical approaches and techniques. Cost estimates are used to help decision makers evaluate resource requirements at key management milestones and decision points in the acquisition process. As a program matures and more information becomes available, the cost estimate grows in complexity and detail.

A.8.2. Basic/Minimum Knowledge:

Concepts, principles, and procedures for performing cost analyses and estimates (for example, learning curves, Cost Estimating Relationships, data collection and adjustment, normalization, overhead rate analysis, production rate analysis, fixed and variable costs, and treatment of inflation).

Operations research techniques (for example, linear programming, queuing theory, modeling and simulation, decision risk analysis, uncertainty analysis, critical path/network analysis).

Concepts, principles, and procedures for performing economic analyses (for example, cost benefit analysis, payback, return on investment, present value, and treatment of inflation).

Policies governing the Cost and Economic Analysis Program.

Materiel acquisition and life cycle management policies and procedures.

Software cost estimating and risk models (for example, SEER, ADA/COCOMO).

A.8.3. Training or Work Assignments Contributing to Basic Knowledge:

ACQ 101 Fundamentals of System Acquisition Management
BCF 101 Fundamentals of Cost Analysis
BCF 206 Cost Risk Analysis
BCF 207 Economic Analysis
BCF 208 Software Cost Estimating

A.8.4. Developmental Path: TBD.

A.8.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.8.6. Sustainment to Maintain Expertise: TBD.

A.9. Common Skill: Domain (Product) Engineering (Analysis, Architecture, Modeling & Implementation)

A.9.1. Description of Skill: TBD.

A.9.2. Basic/Minimum Knowledge: TBD.

A.9.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.9.4. Developmental Path: TBD.

A.9.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.9.6. Sustainment to Maintain Expertise: TBD.

A.10. Common Skill: Feasibility Analysis

A.10.1. Description of Skill: Ability to perform technical analysis of one or various approaches related to a set of training requirements. The engineer must be able to synthesize the technical domains in order to systematically analyze and recommend the best approach to an engineering or training problem. The end result can range from a table of attributes with associated scores, to a detailed technical report.

A.10.2. Basic/Minimum Knowledge:

- Knowledge of STRICOM resources available
  - People with prior experience in the technical area(s)
  - Program data on related programs
  - Ability to perform a data search via the internet or other tools

- Technical background
  - A broad technical background is advantageous. (Visuals, computational, human factors, mechanical and electrical systems, man-machine interfaces, training and training system)
  - Knowledge of previous and ongoing STRICOM programs.
  - Knowledge of what approaches have failed and succeeded.
  - Awareness of current technical trends and technology
  - Awareness of current trends in training
  - Ability to perform trade off analyses
  - Ability to set priority, ranking, and scoring of the attributes relating to the item under analysis.
  - Technical writing abilities
  - Oral presentation abilities

A.10.3. Training or Work Assignments Contributing to Basic Knowledge: TBD

A.10.4. Developmental Path: TBD.

A.10.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.10.6. Sustainment to Maintain Expertise: TBD.

A.11. Common Skill: Functional Analysis and Allocation

A.11.1. Description of Skill: A System Engineering approach to define a baseline of functions and function performance requirements which must be met in order to adequately accomplish the operation, logistics support, test, production, and deployment requirements of the system, and to identify those functions where system life cycle costs are expected to be sensitive to incremental changes in the performance requirements. These functions and their performance requirements will identify areas where trade-offs between input requirements and engineering development require future consideration.

A.11.2. Basic/Minimum Knowledge:

- Be able to develop Use Cases, Alternative OO Analysis techniques, or Functional Flow block diagrams in order to identify and sequence functions that must be accomplished to achieved system objectives.
- Be able to put together Requirement Allocation Sheets
- Knowledge of System Engineering Principles Leadership and communication abilities (Constant communication with the User SMEs)Ability to work in a team environment to develop functional criteria.

Function Identification

- Develop Technologies in coordination with users that can lead to the development of Operational Requirement Documents (ORD) or Training Requirements Documents (TDR).
- Review ORD's or TDR's.
- Meet with User representatives (SME) in order to identify those functions which must be performed to satisfy the objectives of each functional area for all specified modes of usage in all specified environments.
- Describe each function of the system in terms of Use Cases, Logical diagrams, Alternative OO analysis tecniques, or inputs, outputs and interface requirements.

Function Analysis and Allocation

- Develop a system requirement document (SRD) that will satisfy the operational need stated in the ORD or TDR documents.
- Develop a set of performance requirements for each function.
- Identify key requirements that have a strong influence on cost, schedule, functionality, risk, or performance.
- Partition requirements into groups based on established criteria (such as similar functionality, performance, or coupling) to facilitate and focus the requirements analysis.
- Derive, from the system and other (e.g., environmental) requirements, requirements that may be logically inferred and implied as essential to system effectiveness.
- Identify the requirements associated with external interfaces to the system and interfaces between functional partitions or objects.
- Allocate requirements to functional partitions, objects, people, or support elements to support synthesis of solutions.
- Analyze requirements to ensure that they are verifiable by the methods available to the development effort.
- Maintain requirements traceability to ensure that lower level (derived) requirements are necessary and sufficient to meet the objectives of higher level requirements.
- Capture system and other requirements, derived requirements, derivation rationale, allocations, traceability, and requirements status.

A.11.3. Training or Work Assignments Contributing to Basic Knowledge: TBD

A.11.4. Developmental Path: TBD.

A.11.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.11.6. Sustainment to Maintain Expertise: TBD.

A.12. Common Skill: Human Factors Engineering (HFE)

A.12.1. Description of Skill: Responsible for the human factors and MANPRINT issues on a variety of programs. The work would include all elements of HFE for program concept through detail design and production. The work would include request for proposal support and source selection evaluation boards, requirements analysis, mockup and design evaluation, presentations, and application of HFE and MANPRINT principles for the complete program life cycle.

Human factors and MANPRINT issues would include the human engineering of hardware, software, operator, trainer, and maintainer interfaces of both equipment and computers, and test and evaluation.

A.12.2. Basic/Minimum Knowledge:

- Knowledge of human factors experimental methods and analytical techniques.
- Knowledge of Manpower and Personnel Integration (MANPRINT) objects, policy, and regulatory requirements and the ability to communicate MANPRINT across various activities and organizations.
- Ability to access and influence soldier-oriented technology based in light of MANPRINT initiatives.
- Ability to review, coordinate, evaluate, and make input to Human Factors Engineering Assessment (HFEAs), MANPRINT Assessment (MA), and System MANPRINT Management Plan (SMMP) type documentation.
- Perform the role of Contractor Officer Representative (COR) for contracts and delivery orders pertaining to MANPRINT and HFE.
- Skill in written communication.
- Ability to communicate orally.

A.12.3. Training or Work Assignments Contributing to Basic Knowledge:

- Five years or more of professional experience in human factors or ergonomic engineering. Bachelor degree or higher in Engineering, Psychology, or related discipline with a major/minor in human factors from an accredited college or university. An advanced degree in these disciplines may be substituted for one year of experience.
- Ergonomics: Job Analysis and Field Studies Course Number: 9501, University of Michigan
- Advanced Systems Planning Research, Development, and Engineering Course, Defense Systems Management College
- Applied Ergonomics Course, US Army Center for Health Promotion and Preventive Medicine (USACHPPM)
- EIN 6317 Systems Engineering Course, University of Central Florida
- Human Factors Engineering, University of Michigan Summer Course in Continuing Engineering Education
- MANPRINT Practitioners Course, ALMC

A.12.4. Developmental Path: TBD.

A.12.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.12.6. Sustainment to Maintain Expertise: TBD.

A.13. Common Skill: Interoperability (including DIS, ALSP, HLA)

A.13.1 Description of Skill: Interoperability enables distributed heterogeneous simulation systems to be interactive so that a meaningful exercise may be conducted. Two general requirements must be addressed to achieve interoperability. First, an agreed upon communications mechanism must be implemented to enable the systems to dynamically interchange entity, event, and exercise management information during the exercise. Second, the simulations must operate in a common synthetic environment. The synthetic environment includes both the simulated environment of terrain, as well as the state of the simulated entities (appearance, location, velocity, etc.).

A.13.2. Basic/Minimum Knowledge:

Communications:

- Basic Communication Networks
  - Local Area vs. Wide Area Networks (Ethernet, FDDI, T1, ATM, etc.)
  - Bandwidth
  - Packet Size vs. Packet Rates
  - Reliable vs. Best Effort communication protocols (TCP/UDP)
  - Latency
  - Security

- Application Level Protocols
  - High Level Architecture (HLA)
    - Federation Development Process (FEDEP)

  - Run Time Infrastructure (RTI)
    - Federation Management
    - Object Management
    - Declaration Management
    - Ownership Management
    - Data Distribution Management
    - Time Management

  - Object Model Template (OMT)
    - Simulation Object Models (SOMs)
    - Federation Object Models (FOMs)

  - Distributed Interactive Simulation (DIS)
    - Real Time Simulation
    - Protocol Data Units
    - Enumeration's
    - Coordinate Systems (World Coordinate System, UTM, Geodetic)
    - Dead Reckoning
    - Aggregate Level Simulation Protocol (ALSP)
      - Constructive Simulations (Discrete, event driven)
      - Protocol Information

Common Synthetic Environment:

- Synthetic Environments Overview
- Live, Virtual, Constructive Simulations
- Fidelity
- Fair Fight

- Terrain Databases
  - Source Data
  - Database Format/Image Generator Issues
  - Terrain Correlation Issues
  - Interchange Formats (SEDRIS)

- Latency Issues/Effects

- HLA
  - Federation Object Model Development
  - Federation Execution Planner's Workbook

- DIS
  - PDU/Enumeration's Supported

A.13.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.13.4. Developmental Path: TBD.

A.13.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.13.6. Sustainment to Maintain Expertise: TBD.

A.14. Common Skill: Management of Technical Data (Data Management)

A.14.1. Description of Skill: Provides support for the development and oversight of contract data requirements. Provide support in the review of procurement packages for consistency with policy, regulations, and guidance documents. Perform an analysis of data requirements and SOW tasking to ensure consistency between the two. Must be able to understand data requirements required by the customer in order to verify and validate proposed data from the contractor during evaluations. Maintain a data tracking record of both delivered data and data that has been either accepted or rejected. Knowledge of tools available to support customers in the search for Data Item Descriptions, standards, specifications, and other forms of acquisition related documentation. Must be a self-starter and able to use initiative in researching information (there are few formal training opportunities for this area).

A.14.2. Basic/Minimum Knowledge:

- Ability to interpret DOD 5010.12M policy and guidance in the preparation of DD Form 1423s.
- Knowledge of current acquisition policy and contractual requirements in respect to data delivery and oversight.
- Knowledge of current acquisition policy and guidance used in the development of a procurement package, or at least know where to locate this information (i.e., Deskbook, web sites, regs, etc.).
- Understand the process of Ability to monitor and track deliverable data using software tools.
- Knowledge of and ability to use available tools in locating DIDs, standards, specifications and acquisition related documentation.
- Ability to access customer requirements against contractor proposed data.

A.14.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.14.4. Developmental Path: TBD.

A.14.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.14.6. Sustainment to Maintain Expertise: TBD.

A.15. Common Skill: Market Surveys/Trade Studies

A.15.1. Description of Skill: Market research, market survey and trade study skills are used to develop a means of collecting and analyzing information about capabilities within the marketplace to satisfy an agency's needs. These skills include requirement definition, data gathering, interfacing with agency proponents and industry, participating in a team environment, compiling and assessing information. This information is then used to promote and provide: (1) Acquisition of commercial items, or to the extent that commercial items suitable to meet the agency's needs are not available, non-developmental items, to the maximum extent practicable; (2) Full and open competition, or when full and open competition is not required, to obtain competition to the maximum extent practicable, with due regard to the nature of supplies or services to be acquired; (3) Development of new requirements documents for acquisition; and (4) Solicitation of offers for acquisitions.

A.15.2. Basic/Minimum Knowledge:

Market research, market surveys, and trade studies require the following knowledge and abilities:

- Ability to determine if sources capable of satisfying the agency's requirements exist;
- Ability to determine if commercial items or, to the extent commercial items suitable to meet the agency's needs are not available, non-developmental items are available that:
  - Meet the agency's requirements,
  - Could be modified to meet the agency's requirements,
  - Could meet that agency's requirements if those requirements were modified to a reasonable extent;
- Ability to determine the extent to which commercial items or non-developmental items could be incorporated at the component level;
- Knowledge of customary practices regarding customizing, modifying or tailoring of items to meet customer needs, and the associated costs;
- Ability to determine the practices of firms engaged in producing, distributing, and supporting commercial items, such as terms for warranties, buyer financing, maintenance and packaging, and marking;
- Ability to ensure maximum practicable use of recovered materials and promote energy conservation and efficiency;
- Ability to determine requirements of law/regulations unique to the item;
- Ability to identify distribution and support capabilities of potential sources, including alternative arrangements and cost estimates;
- Ability to identify size and status of potential sources.
- Knowledge of the technical implications and issues associated with satisfying the agency's requirements such as:
  - Operating parameters for hardware and software,
  - Environmental conditions for use,
  - Usage (e.g., fixed, airborne, tactically deployable),
  - System interface or integration requirements;
  - Communications/computer interface requirements;
  - Maintainability requirements,
  - Logistics support needs;
- Ability to review results of recent market research for similar or identical requirements;
- Ability to publish formal requests for information in appropriate technical or scientific journals or business publications;
- Ability to query government databases that provide information relevant to agency acquisitions;
- Ability to participate in interactive, on-line communications among industry, acquisition personnel, and customers;
- Ability to obtain source list of similar items from other contracting activities or agencies, trade associations, or other sources;

- Ability to review catalogs and other generally available product literature published by manufacturers, distributors, and dealers, or available on-line;
- Ability to conduct interchange meetings or hold pre-solicitation conferences to involve potential offerors early in the acquisition process;
- Ability to work in a team environment.

A.15.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.15.4. Developmental Path: TBD.

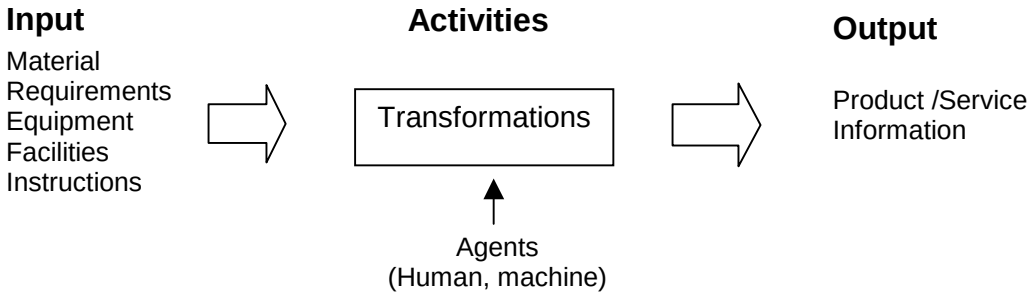
A.15.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.15.6. Sustainment to Maintain Expertise: TBD.

A.16. Common Skill: Process Engineering

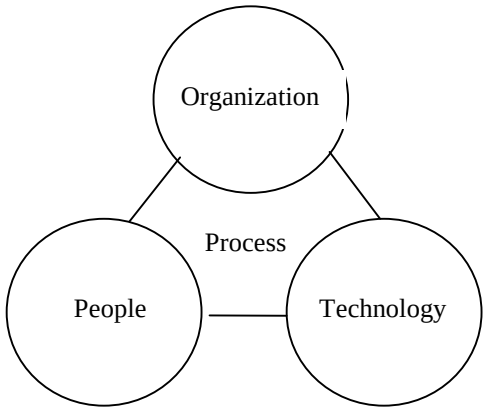
A.16.1. Description of Skill: This should be a specialized skill available to the Commands/E Dir Process Improvement (PI) activity. This skill focuses on increasing the quality and productivity of specific STRICOM product lines while decreasing the cost of developing these product lines. It must be remembered that a process is a means to an end, not the end itself. The following definitions help describe components of this skill.

- Process – A bounded set of interrelated activities that takes one or more kinds of inputs and creates an output(s) that is of value to the customer by means of one or more transformations.
- Process Definition – A layout of a process in terms of activities, artifacts (inputs & outputs), agents (persons or machines), and detail specifications of each.



Process Definition Framework

- Process Model – An abstract representation of a process definition.
- Enactable Process – One that has been completely defined to the extent that it can be successfully executed.
- Project Plan Instantiation – Act of creating an executable process/projects from process definitions.(similar to compiling a computer program from source code).
- Process Engineering – the judicious application of mathematical and scientific knowledge to design and implement processes in order to integrate people, the organization, and its technology to meet certain objectives in a cost-effective fashion.



Process Integrates Enterprise Components

- Process Management – Process definition, instantiation and execution integrates methods, procedures, data, tools, personnel, and facilities into a single cohesive view. There are four phases in process management: (1) Model the workflow/process, (2) Instantiate the project using previously defined processes, (3) Execute/enact the project, and (4) Update the process library with lessons learned.

This skill is best applied relative to maturity level of the organization/project applying the skill. For example, if we use the Software Engineering Institute's (SEI's) Capability Maturity Model (CMM) as a measure of maturity, Process Engineering skills levels should not be expected to be greater than the CMM level of the organization/project. Obviously, training and automated tools would be an integral part of this skill. The following table provides a notional mapping between maturity level/capability of an organization/project and the Process Engineering capabilities & functions that should be applied using automated tools.

CMM level	PROCESS ENGINEERING CAPABILITIES	**Process Engineering (Tool) Functions**
(1) Initial – Few process defined, Ad Hoc Practices	Work & Data Flow Process Definition Metrics Definition Product Definition Static Analysis Plan Generation	Work definition – input/output, process, resources, consequence (what I want to gain from PI, i.e. gain 5% of market, then measure against that consequence) Product definition Measure definition Initial plan generation Process component library
(2) Repeatable – Process discipline to repeat earlier project success	Temporal Analysis Resource Analysis Simulation Project Management	Planning – estimating: sizing & costing, resource allocation & resource leveling, scheduling & critical path calculation Project simulation Final plan generation
(3) Defined – Documented, standardized organizational processes	Data Collection Data Analysis Process Monitoring Enaction Services	Execute Project Monitor & track activities Collects actual metrics (effort included) Reports milestone completions Notifies team members of task status Tracks & integrates document management Reporting (resource & cost) Automatically launches tools Custom reporting
(4) Managed – Process & Product Quality Measurement		
(5) Optimizing - Continuous process improvement, Quantitative process feedback, Technology innovation		

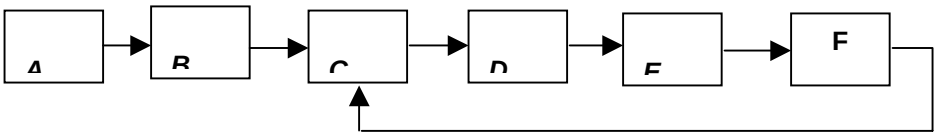
Software Measurement & Analysis. This skill focuses on data-driven decision making. This data-driven decision making is based on a measurement program which provides information that improves decision-making in time to affect the outcome of the process and/or project. A measurement program can: (1) Provide early insight into program risks and potential problems, (2) Provide quantitative support for management decision making, (3) Help forecast trends, (4) Provide visual indicators of progress, (5)

Correlate diverse data and trends, and (6) Track effectiveness of corrective actions. A measurement program can not: (1) Fix a problem or eliminate risk, (2) Identify the solution to a problem, (3) Guarantee product quality, or that the product meets mission goals.

The following IEEE definitions help describe components of this skill.

- Measure – To ascertain or appraise by comparing to a standard. A standard or unit of measurement; the extent, dimensions, etc., of anything, especially as determined by a standard; an act or process of measuring; a result of measurement.
- Measurement – The act or process of measuring something. A result, such as a figure expressing the extent of value that is obtained by measuring. A figure, extent, or amount obtained by measuring.
- Metric – A quantitative measure of the degree to which a system, component, or process possesses a given attribute. A calculated composite indicator based upon two or more measures. A comparison of two or more measures.
- Indicator – A device or variable that can be set to a prescribed state based on the results of a process or the occurrence of a specified condition. For example, a flag or semaphore. A metric that provides insight into software development processes and software process improvement activities concerning goal attainment. Generally compares a metric with a baseline or expected result.

This skill requires a framework to be able to establish a measurement program for a given project or an organization. The following is a description of a framework (or process) for adopting software measurement in an organization/project.



A – ESTABLISH A SUPPORTIVE CULTURE. The purpose of this task is to ensure there is management sponsorship for the adoption of software measurement technologies. Following are tasks to establish a supportive culture:

- Understand the organization's mission and goals
- Establish (or develop) sponsorship for adopting software measurement
- Establish measurement roles and accountability at all levels of the organization

The more significant elements of a supportive culture include:

- Proactive leadership
- Supportive management style
- Open organizational communications
- Quality-oriented work environment

B – DETERMINE CURRENT MEASUREMENT CAPABILITY AND USE. The purpose of this task is to determine how well an organization is using measures and how ready it is for additional technology adoption. The steps for determine the current measurement capabilities include:

- Examine (or evaluate) current use of software measures.
- Examine underlying organizational readiness to implement software measurement.
- Determine current information needs, including project progress, product quality, and process effectiveness.

There are two factors that make the difference in this area to support and effective measurement program. The following two factors are additive to the factors noted above.

- Educated management expectations.
- Effective organizational infrastructure.

C – DEVELOP ORGANIZATION'S MEASUREMENT PLAN. The purpose of this task is to develop a plan to adopt software measurement. This plan is like any project plan because the adoption of technology by an organization must be managed like any other project the organization would undertake. In other words, develop a project plan that will:

- Establish goals and measurable objectives
- Identify risks and mitigation activities
- Identify measurement adoption tasks
- Identify the organization's needs for education and training
- Establish resources and budget requirements to meet objectives
- Define milestones and schedules for implementation
- Gain support for and approval of the plan across the organization

The goals of the project planning are to:

- Establish specific objectives – goals, quotas, or target.
- Define high-level requirements of a statement of work
- Define a realizable, measurable approach to meeting those objectives – actions and strategies to follow
- Risk management – identification of risks, probabilities of occurrence, and mitigation steps
- Establish cost and schedule baselines – time, people, other resources
- Set and manage expectations

D – DEFINE AND USE SOFTWARE METRICS. The purpose of this task is to execute the software measurement adoption plan. The goal is to see the results of measurement in action within the organization.

- Execute the plan
  - Define needed information and data that fulfill the information needs
  - Define software measures to provide needed information
  - Ensure the measures support organizational objectives
  - Implement the defined measures in pilot projects
  - Evaluate progress against plan
- Provide education and training, keyed to your organization, to support software measurement

E – EVALUATE RESULTS. The purpose of this task is to determine how well the initial measurement objectives have been met and to establish a motivation to refine and improve the measurement program over time. The steps are to:

- Determine whether the organization reached the goals and objectives stated in the plan
- Determine whether some goals are unfulfilled
- Establish how the current software measures support objective "data-driven decision making." For example,
  - Has a project performance baseline been established?
  - Are historical data kept to help predict the organization's performance on new projects?
- Establish new measurement goals the organization needs to fulfill. For example,
  - What decisions are still being made without data to support them?
  - What questions need to be answered using objective means?

F – DETERMINE ONGOING NEEDS. The purpose of this task is to provide the foundation to evolve measurement implementation within the organization. Following are questions to be answered to gain insight into the ongoing measurement needs for the organization:

- Is there support to continue work on the measurement goals left unfulfilled?
- Do the current measures show how well the organization is meeting its objectives?
- Do the current measures provide the information needed to support management decisions?
- Do new goals support the organization's mission?
- Does ongoing measurement implementation and refinement have a sponsor?
- Who is accountable for implementing and using software measurement to fulfill the new goals?

In addition to providing a framework, such as the one described above, this skill should have familiarity with the following DoD software measurement initiatives:

- Practical Software Measurement (PSM), Joint Logistics Command, Software Productivity Solutions, Inc.
- U.S. Army Software Metrics / Software Test & Evaluation Panel (STEP) Metrics, DA PAM 73-7, Chapter 10, 15 Jul 96 (pre-publication).
- CECOM Streamlined Integrated Software Metrics Approach (SISMA), U.S. Army CECOM Software Metrics Working Group, Software Productivity Solutions, Inc.
- SEI Software Engineering Measurement & Analysis, Software Engineering Institute (SEI)

A.16.2 Basic/Minimum Knowledge: TBD.

A.16.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.16.4. Developmental Path: TBD.

A.16.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.16.6. Sustainment to Maintain Expertise: TBD.

A.17. Common Skill: Quality Assurance (QA) (Hardware and Software)

A.17.1. Description of Skill: Quality Assurance is a planned and systematic pattern of all actions necessary to provide adequate confidence that management and technical planning and controls are adequate to:

- Establish correct technical requirements for design and manufacturing.
- Create products and services that conform to the established technical requirements.

Quality Engineering (QE) which deals with the principals and practice of product or service quality assurance is to support the accomplishment of the Army's worldwide logistics mission by assuring compliance with contracts, plans, specifications, recognized principals, practices and methods of work. QE positions involve administrative and technical work concerned with monitoring, controlling and maintaining the quality and reliability of material, facilities, services or processes. A person that is fully qualified and certified in quality assurance is normally assigned to ensure that program quality aspects are adequately considered in pre-award, design reviews, configuration audits, quality management system audits, production readiness reviews, etc. Determines contract quality assurance requirements, delegates to contract administration office using Quality Assurance Letter of Instructions, memorandum of agreements, etc. Maybe required to negotiate and approve Quality Assurance Plans. Identifies contract quality assurance process evaluation/proofing, FMECA info, critical characteristics, processes, process evaluation, proofing, process capability, support to design reviews, configuration audits. Defines contract administration authority for material review, class 11 engineering changes, minor waivers and material review. Ensures minimum government verifications consistent with program risk and confidence in contractor operations. Performs product oriented surveys, quality system audits. Acts as the program focal point for quality and provides technical assistance on quality assurance matters.

A.1.7.2. Basic/Minimum Knowledge:

- Explain the transition from Engineering Manufacturing Development (EMD) to production Including: risk assessment from feasibility assessments, the common elements of producibility and concurrent engineering, use of NDI/COTS, use of trade studies, use of transition templates in managing risk, and the objective and conduct of the Production Readiness Review.

- Discuss the use of automation tools, e.g. use of CALS EDI output data, the system used in the design – manufacturing – quality environment, the characteristics of manufacturing simulation software, and flexible computer integrated software management information systems.

- Discuss the various types of specifications involved in goods and services acquisition and related quality assurance and weapon system warranty policy, procedures and responsibilities. Resolve issues relating to processing and maintaining standardization documents.

- Summarize the source selection process, application of FAR/DFAR/OMB circulars, and the importance that the preaward surveys play in the process. Be able to describe who the key decision makers are, and assess source selection manufacturing and QA plans.

- Analyze the levels of QA requirements by the FAR, the application of various FAR clause options, and analyze the various contract quality requirement options.

- Analyze techniques to implement process and system audits, and effective audit interviews.

- Comprehend the Government's policy and objectives pertaining to furnishing Government property to contractors and the resulting responsibilities of the contractor and Government.

- Discuss major requirements and responsibilities of the Government in monitoring , evaluating, improving, and reporting contractor performance. Determine who is responsible for and what criteria

is used to assign the extent of contract surveillance, the categories of production surveillance, and the techniques used to monitor, evaluate, and report contractor performance.

- Assess actions taken to ensure the proper role of the Government representative in engineering changes. Explain the contractual aspects of Value Engineering (VE) including: basic purpose of VE, distinguish the characteristics of a VE change proposal, predict the types of cost savings that can be derived from an effective VE program, and the Government response to processing an acceptable VE Change Proposal (VECP).

- Apply appropriate continuous improvement tools, analyze and resolve issues regarding analytical process evaluations utilizing process capability indices (Cp) and process performance Indices (Cpk). Discuss and predict the act of reduced process variability.

- Comprehend the basic fundamentals of Design of Experiments (DOE).

- Analyze and resolve issues relating to the quality assurance audit and determination of acceptability of inspection and test plans ; develop quality assurance plans to evaluate quality programs and inspection systems.

- Assess prime/subcontractor relationship and discuss the DoD policy in subcontract management from a quality assurance perspective.

- Discuss/analyze the relationship between systems engineering, design, process, and QA.

- Analyze issues resulting from the similarities and differences between ISO 9000 series documents and MIL-I-45208A and MIL-Q-9858A, discuss DoD policy relative to use or non-use of the ISO 9000 documents and other non-DoD/military specifications and standards.

- Analyze actions taken to plan and conduct inspections/audits utilizing statistical sampling methods and resolve relevant issues pertaining to various sampling standards and plans in relationship to confidence levels.

- Analyze data utilizing statistical methods such as ; flow charts, check sheets, Pareto chats, histogram control charts, trend charts, and scatter diagrams, and resolve issues resulting from proper and improper use of these tools.

- Analyze and discuss metrology and calibration system requirements and their relationship to various contract requirements and the necessity for implementation.

- Identify the various types and levels of Government quality assurance programs and assess the actions taken to implement the Government in-plant quality assurance function.

A.17.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.17.4. Developmental Path: TBD.

A.17.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.17.6. Sustainment to Maintain Expertise: TBD.

A.18. Common Skill: Requirements Analysis and Development

A.18.1. Description of Skill: "The requirements document should communicate a complete, consistent, and feasible statement of what is needed in the system." – Peter Coad & Edward Yourdon. Requirements Analysis and Development involves determining what a proposed system needs to do, and expressing this in a format which does not dictate a particular implementation method. Requirements should be designed so the end product meets the users needs. Thus, the end user should be involved in requirements development. Also requirements should be written with the testing in mind. Requirements should strive to be testable and used in the test and evaluation phase of a project. The purpose of this activity is to formalize the needs of the user and establish a list of mandates that the project will be graded against.

A.18.2. Basic/Minimum Knowledge:

- The ability to review and design requirements that insure a method of implementation is not dictated.
- Should be able to functionally decompose a system into its component parts, activities, and subsystems, and then create appropriate requirements based on them.
- Ability to write clear and concise requirements. Requirements should be stated in a manner that allows the system to test against the requirements.
- Should have a good understanding of the system's end user and development methods so realistic requirements that obtain the users goals can be created.

A.18.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.18.4. Developmental Path: TBD.

A.18.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.18.6. Sustainment to Maintain Expertise: TBD.

A.19. Common Skill: Risk Management (Technical (perfromance related), Supportability (performance related), Programmatic (environment related), Cost, and Schedule)

A.19.1. Description of Skill: Risk Management analysis requires analysts to model the risk associated with a major Defense acquisition program. Analyst must possess skills in basic probability concepts, subjective probability assessment, goodness-of-fit testing, and basic simulation concepts.

The acquisition process shall be structured in logical phases separated by major decision points called milestones. The process shall begin with the identification of broadly stated mission needs that cannot be satisfied by nonmateriel solutions. Acquisition program stakeholders shall consider the full range of alternatives prior to deciding to initiate a new MDAP or MAIS. Threat projections, system performance, unit production cost estimates, life-cycle costs, interoperability, cost-performance-schedule trade-offs, acquisition strategy, affordability constraints, and risk management shall be major considerations at each milestone decision point, including the decision to start a new program.

A.19.2. Basic/Minimum Knowledge:

The Analyst must be knowledgeable in the theory and application of qualitative and quantitative methodology, which can be used in conducting a risk assessment, risk management planning, risk analysis, or decision risk analysis. Area of consideration could include subjects in analytical techniques, decision analysis, subjective estimation, network techniques, multiple attribute decision-making, and computer-based simulation using current DoD recommended software.

Risk Analysis is the process by which the performance, cost, and schedule risks of a system are described through qualitative and quantitative methodologies. A program manager, as defined in DoD 5000.2R[1] (paragraph 3.3.2), can use the results of this process to reduce and control these risks. Risk analysis is primarily an on-going internal management tool. Decision risk analysis is a complex study effort to justify major milestone decisions. Risk management consists of five relate activities: risk planning, risk identification, risk analysis, risk assessment, and risk abatement.

Sensitivity Analysis is the process of varying model parameters to see what effects these changes have on a model. This helps to answer the Program Manager's "what-if" questions.

Decision Risk Analysis is a specific form of systems analysis that defines and quantifies the risk associated with alternatives. This structured approach includes a well-defined problem, the establishment of alternatives, sensitivity analysis, and presentation of the analysis to a decision-maker. Such a thorough and complex analysis may take much data analysis. Thus decision risk analysis is used primarily at major decision milestones, or when new alternatives may surface. In contrast, risk analysis is mainly used for continuous day-to-day project management.
Concepts, principles, and procedures for performing cost analyses and estimates (for example, learning curves, Cost Estimating Relationships, data collection and adjustment, normalization, overhead rate analysis, production rate analysis, fixed and variable costs, and treatment of inflation).

Operations research techniques (for example, linear programming, queuing theory, modeling and simulation, decision risk analysis, uncertainty analysis, critical path/network analysis).

Concepts, principles, and procedures for performing economic analyses (for example, cost benefit analysis, payback, return on investment, present value, and treatment of inflation).

Materiel acquisition and life cycle management policies and procedures.

A.19.3. Training or Work Assignments Contributing to Basic Knowledge:

ACQ 101 Fundamentals of System Acquisition Management
BCF 101 Fundamentals of Cost Analysis
BCF 206 Cost Risk Analysis

BCF 207 Economic Analysis
BCF 102 Contract Performance Management Fundamentals Course
BCF 203 Intermediate Contract Performance Management Course

A.19.4. Developmental Path: TBD.

A.19.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.19.6. Sustainment to Maintain Expertise: TBD.

A.20. Common Skill: Safety Engineering

A.20.1 Description of Skill: To be able to assist the Command Staff and Project Managers in the development, implementation and execution of the system safety and occupational health program for the adequate and effective risk management of STRICOM resources, including personnel, equipment, and facilities. To apply engineering and management principles, criteria, and techniques to optimize all aspects of safety within the constraints of operational effectiveness, time, and cost throughout all life cycle phases of STRICOM managed systems. To assist in the development and management of Command safety and health policy, practices, and processes. To participate as a member of IPTs for integration of system safety and health requirements, and the identification, mitigation of safety, and risk assessment and management of hazards. To prepare and approve (or staff, if require) safety and health assessments to support programs' milestone decisions (Safety Assessment Reports, System Safety Risk Assessments, Safety Releases, Health Hazard Assessment, and Environmental, Safety and Health Evaluations). To provide expert advise to the STRICOM community, higher headquarters, other government organizations and private contractors on safety and health issues related with simulation, training and instrumentation systems and programs. To serve as the Command safety and health representative in conferences and meetings sponsored across DoD organizations and the private industry. To conduct accident reporting and investigation. To perform safetyand health inspections of equipment and facilities. To stay abreast, and keep the Command leadership informed, of latest safety and health principles, policy and technology impacting the management of the Command safety and health program.

A.20.2. Basic/Minimum Knowledge:

- Systen Safety analysis Techniques and processes.
- Accident reporting and investigation techniques, procedures, and regulations.
- Perform inspections, assessment and testing involving OSH/SS/HHA/E aspects during design, integration, production and sustainment of equipment and facilities.
- System safety risk management techniques, process, and regulations.
- Prepare, staff (or approve, as required) OSH/SS/HHA/E position to support program milestone decisions (i.e., safety assessment reports, safety releases, and ESHs).
- Knowledge of contractual aspects of OSH/SS/HHA/E within DoD programs.
- Establish of networking relationship with Government and Industry having interest in the Command Safety program.
- Broad knowledge of Federal/State/local policy, regulations and practices related with the Army OSH/SS/HHA/E program.
- Have obtained formal training and education on OSH/SS/HHA/E related fields.
- Ability to analyze complex technical OSH/SS/HHA/E related problems, to develop effective solutions, and to manage the assigned work along with being a contributing member of a multi-disciplined technical team, such as IPTs.
- Ability to communicate effectively, both orally and in writing, in working-out solutions to problems or questions relating to the work

A.20.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.20.4. Developmental Path: TBD.

A.20.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.20.6. Sustainment to Maintain Expertise: TBD.

A.21. Common Skill: Soliciting, Evaluating, Negotiating, Debriefing, and Awarding Proposals

A.21.1. Description of Skill: TBD.

A.21.2. Basic/Minimum Knowledge: TBD.

A.21.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.21.4. Developmental Path: TBD.

A.21.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.21.6. Sustainment to Maintain Expertise: TBD.

A.22. Common Skill: Technical Architecture (Army/Joint)

A.22.1. Description of Skill: TBD.

A.22.2. Basic/Minimum Knowledge: TBD.

A.22.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.22.4. Developmental Path: TBD.

A.22.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.22.6. Sustainment to Maintain Expertise: TBD.

A.23. Common Skill: Value Engineering

A.23.1. Description of Skill: To be able to integrate the Value Engineering Methodology into every process or procedure that will ultimately reduce the costs associated with systems development and life-cycle management. Apply a continuous workshop approach to involve Integrated Product Teams in function analysis early on and throughout the life cycle to identify value improvement. This approach integrates the expertise of related initiatives like Technology Insertion, Modernizations through Spares, Cost as an Independent Variable, and Operation and Support Cost Reduction. For this approach to maximize its effectiveness, partnering arrangements must be made with industry to identify and exploit value improvement opportunities. Partnering arrangements will be required in all solicitations/contracts whereby the government/contractor team convenes at contract inception and jointly researches, develops, pre-evaluates, and pre-negotiates Value Engineering Proposals. This arrangement will allow for pre-approved proposals to be submitted, thus reducing processing time and maximizing the benefits to both the contractor and the government.

A.23.2. Basic/Minimum Knowledge:

- Functional Analysis System Techniques.
- Cost Estimating.
- Contractual Aspects of Value Engineering.
- Practical Applications of Value Engineering (VE Methodology).
- VE Partnering with industry contractual language and guidance.
- Continuous Workshop Approach.
- Related initiative general understanding to maximize the opportunities available.

A.23.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

A.23.4. Developmental Path: TBD.

A.23.5. Training or Work Assignments Comprising Developmental Path: TBD.

A.23.6. Sustainment to Maintain Expertise: TBD.

A.24. Common Skill: Verification, Validation, and Accreditation (VV&A)

A.24.1. Description of Skill: M&S credibility is measured by verification and validation (V&V) and formally approved as adequate for use in a particular application by accreditation. The entire process is known as VV&A. Verification is the process of determining that a model and its resultant simulation accurately represent both what is required and what the M&S developer says will be built in accordance with the requirements. Validation is the process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model. Accreditation is the official certification that a model or simulation is acceptable for use for a specific application.

A.24.2. Basic/Minimum Knowledge:

- Understanding of Acquisition Milestones and Phases
- Understanding of the Program Acquisition Categories: ACAT I, II, III, IV
- Understanding of the VV&A Process in the Acquisition Process
- Familiarization with the following policies, regulation, and guides:
  DOD 5000.1 "Defense Acquisition"
  DODD 5000.59 "DOD Modeling and Simulation (M&S) Management"
  AR 70-1 "Army Acquisition Policy"
  AR 73-1 "Test and Evaluation Policy"
  MIL-STD-498 "Software Development and Documentation"
  AR 5-11 "Army Model and Simulation Management Program"
  DA PAM "VV&A of Army Models and Simulations"
  "DOD VV&A Recommended Practices Guide"
- Understanding of Roles/Responsibilities of the following:
  Materiel Developer
  Combat Developer
  IV&V Agent
  Accreditation Agent
  Proponent/User

A.24.3. Training or Work Assignments Contributing to Basic Knowledge:

- ACQ 101 – Fundamentals of Systems Acquisition Process
- TST 101 – Introduction of Acquisition Workforce Test and Evaluation
- TST 202 – Intermediate Test and Evaluation
- TST 301 – Advanced Test and Evaluation
- SAM 201 – Software Acquisition Management
- ISO 9000 – Quality Standards
- Metrics Training

A.24.4. Developmental Path: TBD

A.24.5. Training or Work Assignments Comprising Developmental Path: TBD

A.24.6. Sustainment to Maintain Expertise: TBD

Appendix B

Program Engineering Specific Skills

B.1. Specific Skill: Analysis of Drawings

B.1.1. Description of Skill: TBD.

B.1.2. Basic/Minimum Knowledge: TBD.

B.1.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

B.1.4. Developmental Path: TBD.

B.1.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.1.6. Sustainment to Maintain Expertise: TBD.

B.2. Specific Skill: Audio System Design

B.2.1. Description of Skill: TBD.

B.2.2. Basic/Minimum Knowledge: TBD.

B.2.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

B.2.4. Developmental Path: TBD.

B.2.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.2.6. Sustainment to Maintain Expertise: TBD.

B.3 Specific Skill: Command, Control, Communication, Computers and Intelligence (C4I)

B.3.1. Description of Skill: C4I requires a good understanding of the Joint/Army military protocols, battlefield tactics, hardware/software capability, countermeasures, network and transmission performance, satellite communication, and working knowledge on different types of C4I technologies and their integration. C4I applications are applicable in Heavy Armor (M1), Med (Sheridan) And Light (Bradley), Air-to Air/Air-to-GND/Air-to-Sea warfare.

Ideally, the engineer should have "military" experience in the fields such as the Signal, Artillery, and Communication Corps. He/She also should be familiar with field operation (e.g., been through a war game, actual rotation, joint exercise). The C4I field is very board. Many areas of specialization are need of SME. The generalists cover the areas of planning, integration, and fielding of the C4I system. The specialists cover the areas of telecommunications, data link, transmission equipment.

He/She should have an EE/CS degree and taking courses from the military schools. Temporary job assignment (e.g., Internship at Pentagon, participate in war-game, partnership with Navy) should help. Also encourage the military people to teach class relating to field operation.

B.3.2. Basic/Minimum Knowledge: TBD.

B.3.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

B.3.4. Developmental Path: TBD.

B.3.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.3.6. Sustainment to Maintain Expertise: TBD.

B.4. Specific Skill: Domain (Product) Engineering (Analysis, Architecture, Modeling & Implementation)

B.4.1. Description of Skill: TBD.

B.4.2. Basic/Minimum Knowledge: TBD.

B.4.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

B.4.4. Developmental Path: TBD.

B.4.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.4.6. Sustainment to Maintain Expertise: TBD.

B.5. Specific Skill: Electromagnetic Environmental Effects (E3) Engineering

B.5.1. Description of Skill:

Develop acquisition criteria/requirements necessary for a contractor to ensure the training/instrumentation system hardware is electromagnetically compatible(EMC) among all subsystems and equipment within the system and with the electromagnetic environments (EME) caused by electromagnetic environmental effects (E3) external to the system. Further ensure that some level/type of verification is accomplished to ensure EMC within the system and with the known external environments prior to use in those intended EMEs. Performance/verification requirements shall address all life cycle aspects of the system, including (as required) normal in-service operation, checkout, maintenance, storage, transportation, handling, packaging, launch, and with the normal operating procedures associated with each aspect. Once fielded investigate and determine cause of reported E3 problems.

B.5.2. Basic/Minimum Knowledge:

It is not necessary for every engineer to be an "expert" in E3. What is necessary is for every engineer to become aware of E3 and the general implications it has. If help is needed a subject matter expert (e.g., National Association of Radio and Telecommunications Engineer (NARTE) Certified EMC Engineer) should be consulted. Every engineer has been through a basic electronics course in college, what was not provided in college is the implications of E3 in relation to circuit operation, analysis, design, and maintenance.

B.5.3. Training or Work Assignments Contributing to Basic Knowledge:

a. Knowledge required:

- Basic electronic/electrical theory;
- Electrical dimensions and units of measurement (wavelengths, decibels, volts/meter, etc.);
- Governmental requirements;
- Aspects of E3 (sources, transfer paths, receptors, emissions, immunity, spectrum management, etc.)
- E3 Measurements of emissions and immunity;
- Advantages and constraints of E3 design (cost, schedule, manufacturability, interpretability, product appearance, affordability, etc.);
- Describe and understand operational, storage, transportation electromagnetic environments (EME);
- And understanding of grounding (i.e., signal, power, safety, etc.); and
- Operation of the hardware

b. Ability to:

- Describe the EME(s) in which the hardware will operate;
- Determine E3 performance requirements for project;
- Understand the potential E3 control techniques bidders can used to meet performance requirements
- Understand the potential methods bidders/contractor can utilize to verify performance requirements.
- Understand when a frequency allocation/assignment is required
- Understand the cost/schedule/performance impacts of proposed designs
- Understand the cost/schedule/performance risks impacts of proposed designs
- Understand the impacts of changes/ECP's/ECN's/modifications to design
- Understand implications and procedures of bidders/contractors verification method (demo, analysis, inspection, test)
- Analyze/evaluate E3 test data
- Investigate/analyze E3 problems to determine cause and fix. Also in those cases where report is determined not to be an E3 problem provide sufficient data to justify no E3 action.

c. Training:

- An E3 Awareness course/seminar;
- An E3 course (2 weeks), which includes:
  - Governmental requirements (Military, Commercial);
  - Measurements requirements (Military, Commercial);
  - E3 Control Components (wires, inductors, capacitors, filters, RF shielding, Ferrite's)
  - Spectrum Analysis of signals/emissions;
  - Antenna Electromagnetic Theory;
  - Radiated Emissions and Immunity Principles;
  - Conducted Emissions and Immunity Principles;
  - RF shielding Principles;
  - Electrostatic Discharge Principles;
  - Available Literature;
  - Real life E3 problems;
  - Importance of Spectrum/Frequency Management
- Simulation and Modeling of E3 principles.

B.5.4. Developmental Path:

It is estimated by NARTE that it takes 5 years to grow an E3 Engineer, of course this depends on time spent dealing with E3. It would be difficult to be an "expert" when working part time at E3 Engineering. Proficiency is gained by working and addressing E3 Engineering and taking/attending both free and pay-for seminars and courses and reading industry published articles in free publications. The more specific work in E3 the more proficient one becomes in E3.

- Project Engineer/Technician:
  - Entry Level: monitoring E3 design/testing for a project in one of the following platform areas:
    - Ground/vehicle;
    - Airborne;
    - Instrumentation;
    - Shipboard.
  - Intermediate Level: In addition to entry level knowledge/ abilities the ability and to evaluate the E3 area on proposals in one of the platform areas
  - Lead Level: In addition to the entry and immediate level knowledge/abilities the ability and knowledge to determine and provide acquisition package inputs, in one of the platform areas.
  - "Expert" Level: Ability to handle all the above levels in all platform areas plus certification as a NARTE Certified EMC Engineer.

- Assignments making the individual responsible for a different platform area. The E3 control principles are the same, the electromagnetic environment is different for each platform type as is the application of the E3 control techniques.
- Assignment working with a Logistics Manager (interface with users and maintainers during operational life cycle phase) in determining E3 problems and fixes
- Assignment working as a Test Engineer responsible for hardware E3 testing
- Assignment working as a Systems Engineer

B.5.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.5.6. Sustainment to Maintain Expertise: TBD.

B.6. Specific Skill: Environmental Engineering

B.6.1. Description of Skill: An awareness that every program requires an Environmental, Safety, and Health (ESH) evaluation, per Section 4.3.7 (Environment, Safety, and Health), DOD 5000.2R. Specific environmental issues addressed in the ESH are the National Environmental Policy Act (NEPA), Hazardous Materials, Pollution Prevention, and Environmental Compliance.

B.6.2. Basic/Minimum Knowledge:

- General understanding of NEPA.
- Knowledge of the contents of an ESH and when required.
- An awareness that federal, state, or local regulations may apply to waste streams generated by fielded systems.

B.6.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

B.6.4. Developmental Path:

- NEPA - ALMC (Fort Lee) offers a four day course in NEPA. I believe that they will come to the customer's site if requested.
- ESH - Section 4.3.7 (Environment, Safety, and Health), DOD 5000.2R addresses the contents of the ESH.
- Waste Disposal - This is covered in the acquisition courses: ACQ 101, SYS 201, and SYS 301.

B.6.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.6.6. Sustainment to Maintain Expertise: None required.

B.7. Specific Skill: Facilities Engineering

B.7.1. Description of Skill: Position requires the application of a thorough professional knowledge of two or more engineering disciplines, including engineering concepts, principles and practices applicable to a broad range of facility and training system assignments and familiarity with the other engineering disciplines related to the work of the position (i.e., architectural, civil, mechanical, electronic and electrical engineering). The incumbent must possess a knowledge of construction techniques and practices; a knowledge of Army public works practices; and a knowledge of facility planning practices and procedures. Additionally, the incumbent requires a general knowledge of the functioning and life cycle of training devices. The incumbent must have the ability to adapt precedents or make significant departures from previous approaches in order to provide for requirements for specialized projects.

B.7.2. Basic/Minimum Knowledge: TBD.

B.7.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

B.7.4. Developmental Path: TBD.

B.7.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.7.6. Sustainment to Maintain Expertise: TBD.

B.8. Specific Skill: Hardware Configuration Management

B.8.1. Description of Skill: Configuration Management (CM) is the application of technical and administrative direction and surveillance to identify and document the functional and physical characteristics of an item (Configuration Identification), to control identification and changes to those characteristics (Configuration Control), and to record and report change processing and implementation status (Configuration Status Accounting). It also includes technical reviews and audits (Configuration Audits). This skill element describes configuration management at the system and hardware level. It does not include configuration management of software.

B.8.2. Basic/Minimum Knowledge:

- Change control methods/procedures such as configuration control boards (CCBs) and the documentation necessary to support.
- Documentation types and content. Most importantly performance specifications.

B.8.3. Training or Work Assignments Contributing to Basic Knowledge:

- Need a STRICOM SOP to standardize configuration control procedures and documentation. Have each engineer responsible for processing the change impacting his/her area of expertise.
- Possibly put together a short handbook summarizing the various types of technical documentation in order to assist engineering in acceptance of PDD and performance specifications.
- Review of MIL-STD-961, with respect to performance specifications.
- Attendance at STRICOM seminars/workshops on use of performance specifications.

B.8.4. Developmental Path:

- Configuration Identification:
  - Part numbering conventions.
  - Documentation types and content required for each.
  - Drafting/documentation standards.
- Configuration Control:
  - Change control methods/procedures such as configuration control boards (CCBs), both for contractor and government controlled documentation.
  - Documentation required to record changes to the established configuration, both for contractor and government controlled documentation.
- Configuration Status Accounting:
  - Knowledge of configuration management databases.
  - Types of data which needs to be collected and tracked in order to maintain an effective configuration management program.
- Configuration Audits:
  - Knowledge of audit techniques and reporting methods.

B.8.5. Training or Work Assignments Comprising Developmental Path:

- See training for Basic Knowledge/Abilities above.
- Participation in contractor CCBs and Government CCBs.
- Participation in a configuration audit.
- Participation in documentation reviews.
- Review of drawing standards such as MIL-STD-100, and industry drafting standards.
- Formal training in a DoD Configuration Management course.

B.8.6. Sustainment to Maintain Expertise:

- Review of current STRICOM and higher headquarters' directives and guidance pertaining to configuration management and technical data (including performance specifications).

B.9. Specific Skill: High Level Architecture (HLA)

B.9.1. Description of Skill: The application of the High Level Architecture principles to current and future simulations.

B.9.2. Basic/Minimum Knowledge:

- Knowledge of the benefits of the High Level Architecture
- Understanding of the options for making a simulation HLA compliant
- Knowledge of the components of Simulation and Federation Object Models
- Understanding of the process for creating an HLA federation
- An understanding of the HLA tools available, where those tools fit in the development process and the ability to apply those tools
- Knowledge of the compliance testing process.
- Ability to assess tradeoffs of various HLA approaches
- Understanding of the capabilities of Runtime Infrastructure Software
- Understanding of the Federation Execution Process and what is required to develop a federation execution.
- Ability to develop a Simulation or Federation Object Model
- Knowledge of the Runtime Infrastructure Services and how they work

B.9.3. Training or Work Assignments Contributing to Basic Knowledge:

- Multiple training courses exist for basic to advanced training. Including courses offered by DMSO, the STRICOM HLA team and other contractors.
- Work assignments in this area are limited at this time although there are many programs that have HLA requirements. The work assignments should increase within the next year or so. The ECRC currently has a couple of people working on HLA training. These slots will open up again shortly for new individuals

B.9.4. Developmental Path: Attending the general HLA courses offered followed by some of the specific courses offered on some of the HLA tools.

B.9.5. Training or Work Assignments Comprising Developmental Path: An ECRC rotation or a rotation to a program becoming HLA compliant is appropriate.

B.9.6. Sustainment to Maintain Expertise: Sustainment of the skill will involve attending courses as the HLA progresses.

B.10. Specific Skill: Lasers/Optics

B.10.1. Description of Skill: TBD.

B.10.2. Basic/Minimum Knowledge: TBD.

B.10.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

B.10.4. Developmental Path: TBD.

B.10.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.10.6. Sustainment to Maintain Expertise: TBD.

B.11. Specific Skill: Network Communications Engineering

B.11.1. Description of Skill: TBD.

B.11.2. Basic/Minimum Knowledge: TBD.

B.11.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

B.11.4. Developmental Path: TBD.

B.11.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.11.6. Sustainment to Maintain Expertise: TBD.

B.12. Specific Skill: Post Deployment Systems Support (Hardware and Software)

B.12.1. Description of Skill: The process of PDSS or Logistics support of a system after fielding contains basic elements:

- CM (Configuration Control)
- QA (Test, VV&A)
- New interface control and core system development control
- Review of drawings, manuals, development documents.
- Customer and future system requirements.
- Risk analysis, software capabilities measurement, functional/performance based analysis.
- Knowledge of regulations, standards and SW/HW development and deployment standards.

The process delineated will lead to the functional skills need, thus the training required to successfully accomplish these tasks. While these tasks do tend to meld together, there are very definite skills needed to successfully accomplish the duties required.

The Life Cycle management of a system contains all monitoring and interface control of a system as a whole to ensure the system works as required and to insure that new items or upgrades to the system can correctly be interfaced with it, as well as provide the correct functional/performance actions required by the customer.

B.12.2. Basic/Minimum Knowledge: Knowledge for this skill include:

- Usage and ability to read and understand a High Level Language HLL, as well as ability to understand a review the functionality aspects of multiple current HLL.
- Knowledge and ability to create and understand drawing created on a CAD type system, and to inspect hardware items for correctness and completeness in configuration.
- Knowledge of needed documents, to include manuals and design documents and ability to discern if all the functional elements with in the documents are up to date and complete.
- Knowledge of new systems integration efforts and techniques, and ability to participate in integration efforts to include posting of integration control features to control documents.
- Knowledge of systems designs and functionalities based on system engineering principals and basic systems' interoperability configurations.
- Ability to lead or participate in VV&A activities as necessary to insure Configuration Control of the assigned systems.
- Ability to communicate technical and administrative issues to PDs and contractor representatives in a logical, concise and tactful manner.
- Ability to be a team player and work in and IPT in such a manner as to insure that the team build the best product for the soldier.

B.12.3. Training or Work Assignments Contributing to Basic Knowledge:

B.12.4. Developmental Path: The development path is broken down into 3 levels:

- The first level is the journeyman level where the person is learning what PDSS is all about. At this level the person needs to have basic knowledge methods for VV&A, Software risk management and measurement and acquisition. Technical knowledge in design languages and configuration management metrologies is necessary. Quality control procedures and ability to provide assistance in interface control issue are necessary. Lastly knowledge of and ability to use CASE (in General) is helpful.
- The second level builds on the first in the system engineering capabilities are required. The skills addressed above need to be mastered in such a manner that the person can lead a project in the utilization of CASE tools and administration of QA, CM, VV&A, Software Measurement and Risk Management activities.

- The last level is where the individual has the abilities to make management decisions for system stability and continued operational capabilities base on the skills acquired. The individual may lead or facilitate the efforts of CCBs, ICD-IPTs etc. based on the management needs of the system. The person needs to have significant capabilities for QA of HW, SW and over systems capabilities.

B.12.5. Training or Work Assignments Comprising Developmental Path:

Training should include courses and Job experience in:

- CASE Tools
- CALS methodologies and tools
- Software measurement and Risk Management
- Software Acquisition
- Acquisition Reform and methodologies
- Software Languages Utilized
- Operating systems utilized
- QA/CM policies and methodologies
- Personal development in LEADS and PME courses
- Logistics Management Courses; e.g. COR, COTR
- Program Management Courses
- IEEE, ISO and Software Development, Maintenance and documentation requirements courses.
- Maintain proficiency in Government regulatory systems and documents such as the DoD 5000 series for Defense Acquisition, the Army acquisition, Test and Evaluation policies, VV&A Recommended Policies Guide(s), and Environment Test Methodologies Guides. The individual should have EPA and OSHA knowledge for system work in the field and knowledge in the processes their system uses to accomplish the functions needed. Acquisition processes and policies should also be known, and update in the processes must be constant.

Level 1 personnel should be assigned to an experienced PDSS person to insure they have the backing and field knowledge to accomplish the tasks necessary. The skills to be developed will be management skills and measurement skills based on systems compliance issue, CM, QA and acquisition training.

Level 2 personnel should have the ability to lead their own project with assistance from a level 3 person. These people will start leading projects and making decisions about QA/CM and compliance issues based on system experience and capabilities to make sound judgments based on prior PDSS experience.

Level 3 personnel will lead projects and advise lower level personnel on project administration. They will keep up to date with the latest acquisition policies, Languages, CM/QA/VV&A procedures and how to practically measure systems capability and manage risk.

B.12.6. Sustainment to Maintain Expertise: All levels will need continued sustainment training on use of CASE tools, management tools, CALS tools and other Acquisition management tools. This is to be accomplished through trade shows, special classes, and demonstrations and maintenance of current technological knowledge via University classes and outside associations with professional software, hardware and systems engineering organizations.

All levels of PDSS will maintain an IPT capability and show the capability of working with other professionals in CM/QA and other field of system PDSS processes.
All levels will need to maintain a knowledge of customer needs through participation in field activities such as unit rotations, field exercises, field tests, and ground tests of soldier interface items.

All levels need to involved in the fielding of new systems that will interface their projects, to the extent that they are aware of interface issues and participate in the interface design and fielding of the new systems.

All levels of PDSS persons should obtain at least 1 CE level three certification, preferably in SPRDE or Testing/Logistics support.

All levels need to maintain up to date knowledge through training courses for specific systems, Technical University or specialty schools, and trade shows/professional organizations. All levels need to read technical trade journals and maintain up to date proficiency in Software and Hardware developments for integration of new capabilities into the systems being supported.

B.13. Specific Skill: Production and Producibility Engineering

B.13.1. Description of Skill: This skill encompasses Production Engineering and associated Producibility Engineering expertise for establishment of production lines for various products; preparing and implementing production plans; developing manufacturing cost estimates based on established or planned production lines; analyzing existing and planned production setups and preparation of assessments and recommendation for manufacturing and production facilities improvements and cost reductions.

B.13.2. Basic/Minimum Knowledge:

- Must be knowledgeable of production and manufacturing operations.
- Must have the ability to read and interpret facilities and product Drawings and technical information to include manufacturing processes, procedures and instructions.
- Must have knowledge of equipment, tooling and tooling concepts special testing and test equipment requirements, and manufacturing/production processes and process control.
- Must understand manufacturing processes, flow, and facility layouts as well as time study processes and learning curve analysis and techniques that are used to plan for economic establishment of production facilities and lines.
- Must be current on recent developments in manufacturing processes and equipment, performance of trade studies and preparation of presentations for management consideration and approval of alternative production methods.
- Should have, as a minimum, a BS degree in Mechanical, Electrical, Manufacturing, or Industrial Engineering and at least 10 years of manufacturing and production related experience.
- Must have the ability to perform Production Readiness Reviews and Assessments
- Must have knowledge and full understanding of quality, program management, logistics and engineering to be able to conduct successful reviews and lead a team through a complete audit and preparation of conclusions/recommendations.

B.13.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

B.13.4. Developmental Path:

Personnel assigned to this area must have a BS degree in either Mechanical, Electrical, Industrial, Civil, or Chemical Engineering. Initial assignment should be supporting a senior engineer performing the above duties. Personnel should be exposed to ongoing programs in the Engineering Manufacturing Development (EMD) phase. Assignments should include the monitoring of production planning efforts; review of production and manufacturing plans; preparation of inputs for and evaluation of production proposals for both technical and cost merit. Personnel should be exposed to contractors that are in the planning and preparation phase of production efforts and participate in the review and implementation of production plans, establishment of facilities and prove out of equipment and processes. Personnel should participate in the planning for Milestone Decision Reviews and all related activities that lead to approvals for continuation into production. Experience in the development of manufacturing processes, technology, as well as machinery, tools and test equipment is considered essential for performance as a Production Engineer.

B.13.5. Training or Work Assignments Comprising Developmental Path:

Training should provided in the conduct of Production Readiness and Assessment, Learning Curve Theory and Application, Manufacturing Cost Estimating, Time and motion Studies, and Production Management.

Work assignments should include:

- Preparation of RFPs and evaluation of contractor proposals,
- Production contract monitoring,
- Production Plan assessments, implementation and proveout,
- Equipment and tooling design and analysis,
- Manufacturing process development,
- Field office representative at production facility,
- Planning and conduct of production reviews and assessments

B.13.6. Sustainment to Maintain Expertise: TBD.

B.14. Specific Skill: Program Engineering

B.14.1. Description of Skill: To be able to assist the Command Staff, Project Managers, E Directorate, and other customers in the development, implementation and execution of the engineering program for the adequate and effective management of STRICOM resources, including personnel, equipment, and facilities. To assist in the development and management of Command R&EM best practices and processes to meet customer's objectives. To provide PM/PDs engineering matrix support as a member of IPTs for integration of engineering requirements and activities through the life cycles of assigned systems. To represent the Command and the E Directorate in meetings, conferences and committees involving representatives industry and other government organizations. To perform engineering analyses, assessments and testing of Command managed equipment and facilities. To provide engineering expert advise and assessment to Command customers, including Users of STRICOM developed equipment concerning system engineering problems identified during the sustainment phase. To stay abreast, and keep the Command leadership informed, of latest policy, processes, and technology impacting the management of the R&EM program.

B.14.2. Basic/Minimum Knowledge:

- R&EM Analysis Techniques and system engineering processes.
- Knowledge of the IPT process and ability to work as a team member.
- Knowledge of contractual aspects of R&EM within DoD programs.
- Establish of networking relationship with Government and Industry having interest in the Command R&EM program.
- Broad knowledge of Federal/State/local policy, regulations and practices related with the Army R&EM program.
- Have obtained formal training and education on RE&M related fields.
- Ability to analyze complex technical engineering related problems, to develop effective solutions, and to manage the assigned work along with being a contributing member of a multi-disciplined technical team.
- Ability to communicate effectively, both orally and in writing, in working-out solutions to problems or questions relating to the work.

B.14.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

B.14.4. Developmental Path: TBD.

B.14.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.14.6. Sustainment to Maintain Expertise: TBD.

B.15. Specific Skill: Radio Frequency (RF) Communications Engineering

B.15.1. Description of Skill: An RFC Engineer should have a basic understanding of the science and technology of RF communication systems. The RFC engineer should have and understanding of how an RFC system works and an understanding of counter measures and counter-counter measures. Additionally, the RFC engineer should be familiar with pending laws and how they will affect the Army systems managed by STRICOM.

B.15.2. Basic/Minimum Knowledge: An understanding of modulation techniques, receiver design, antenna design and the physics of wave propagation are required. The RFC engineer should be familiar with the RF spectrum and with the uses as well as the advantages and the disadvantages inherent in the frequencies of interest. On a more general note, the RFC engineer should be aware of the advances in communications being driven by both the military and private sector. Since interference and jamming are the problems encountered most frequently, direction finding and frequency management skills will be required.

B.15.3. Training or Work Assignments Contributing to Basic Knowledge:

College courses are the best methods for developing skills in the physics involved in RF communications. Experience with the communication systems used in STRICOM programs and the problems encountered with these systems is the best way to develop the skills needed to be an expert within the command.

B.15.4. Developmental Path:

- Engineers who wish to become experts in this field should strive to obtain a masters degree in electrical engineering with focus on the specialization areas of Communications and Electromagnetics with probably a class or two in Digital Signal Processing. The list of available courses can be obtained from the UCF catalog.
- Programs involving the CTCs and the Test Ranges instrumentation and frequency management are the best vehicles to gain experience in the real world problems encountered in this field.
- Participation at frequency managers conferences and RF communication symposiums would be necessary to maintain these skills. Subscriptions to periodicals in the field would also be beneficial.

B.15.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.15.6. Sustainment to Maintain Expertise: TBD.

B.16. Specific Skill: Reliability, Availability, and Maintainability (RAM) Engineering

B.16.1. Description of Skill: Provides a focused approach to achieve operational requirements and operating and support (O&S) cost targets. Throughout development and system operation, RAM engineering must continue to explore ways to optimize the balance between reliability and maintainability investment, operational performance and support cost.

B.16.2. Basic/Minimum Knowledge:

- Participate in the combat developer efforts to establish RAM requirements.
- Develop and implement a RAM program that is tailored in scope, content, and design to ensure that the user operational reliability requirements will be met
- Provide the Materiel Developer's portion of the RAM Rationale Report
- Develop the reliability and maintainability sections of specification, Statement of Work, and other appropriate contractual documents
- Chair the RAM Integrated Product Team and provide concurrent engineering support
- Chair the RAM Working Group and RAM Scoring Conferences
- Develop RAM portions of the appropriate sections of the TEMP
- Present RAM status and plans to the Test Integration Working
- Track fielded system failure and repair histories

B.16.3. Training or Work Assignments Contributing to Basic Knowledge:

- Knowledge of the process to generate RAM requirements and RAM Rationale Report
- Knowledge of the RAM Integrated Development Team process and activities
- Knowledge of the FMECA and FRACAS development process
- Ability to perform statistical test design and data analyses
- Ability to perform reliability growth planning and assessment
- Knowledge of applicable DoD/army directives, regulations and handbooks
- Leadership and communication abilities

B.16.4. Developmental Path:

- Graduate level courses in statistics and experimental design
- RAM-related courses through AMEC
- RAM symposia and conferences
- On-site briefings provided by AMSAA
- Participation in professional societies, such as Society of Reliability Engineers

B.16.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.16.6. Sustainment to Maintain Expertise: TBD.

B.17. Specific Skill: Risk Management

B.17.1. Description of the Skill:

Risk Management analysis requires analysts to model the risk associated with a major Defense acquisition program. Analyst must possess skills in basic probability concepts, subjective probability assessment, goodness-of-fit testing, and basic simulation concepts.

The acquisition process shall be structured in logical phases separated by major decision points called milestones. The process shall begin with the identification of broadly stated mission needs that cannot be satisfied by nonmateriel solutions. Acquisition program stakeholders shall consider the full range of alternatives prior to deciding to initiate a new MDAP or MAIS. Threat projections, system performance, unit production cost estimates, life-cycle costs, interoperability, cost-performance-schedule trade-offs, acquisition strategy, affordability constraints, and risk management shall be major considerations at each milestone decision point, including the decision to start a new program.

B.17.2. Basic/Minimum Knowledge:

The Analyst must be knowledgeable in the theory and application of qualitative and quantitative methodology, which can be used in conducting a risk assessment, risk management planning, risk analysis, or decision risk analysis. Area of consideration could include subjects in analytical techniques, decision analysis, subjective estimation, network techniques, multiple attribute decision-making, and computer-based simulation using current DoD recommended software.

Risk Analysis is the process by which the performance, cost, and schedule risks of a system are described through qualitative and quantitative methodologies. A program manager, as defined in DoD 5000.2R[1] (paragraph 3.3.2), can use the results of this process to reduce and control these risks. Risk analysis is primarily an on-going internal management tool. Decision risk analysis is a complex study effort to justify major milestone decisions. Risk management consists of five relate activities: risk planning, risk identification, risk analysis, risk assessment, and risk abatement.

Sensitivity Analysis is the process of varying model parameters to see what effects these changes have on a model. This helps to answer the Program Manager's "what-if" questions.

Decision Risk Analysis is a specific form of systems analysis that defines and quantifies the risk associated with alternatives. This structured approach includes a well-defined problem, the establishment of alternatives, sensitivity analysis, and presentation of the analysis to a decision-maker. Such a thorough and complex analysis may take much data analysis. Thus decision risk analysis is used primarily at major decision milestones, or when new alternatives may surface. In contrast, risk analysis is mainly used for continuous day-to-day project management.
Concepts, principles, and procedures for performing cost analyses and estimates (for example, learning curves, Cost Estimating Relationships, data collection and adjustment, normalization, overhead rate analysis, production rate analysis, fixed and variable costs, and treatment of inflation).

Operations research techniques (for example, linear programming, queuing theory, modeling and simulation, decision risk analysis, uncertainty analysis, critical path/network analysis).

Concepts, principles, and procedures for performing economic analyses (for example, cost benefit analysis, payback, return on investment, present value, and treatment of inflation).

Materiel acquisition and life cycle management policies and procedures.

B.17.3. Training or Work Assignments Contyributing to Basic Knowledge:

- ACQ 101 Fundamentals of System Acquisition Management
- BCF 101 Fundamentals of Cost Analysis
- BCF 206 Cost Risk Analysis
- BCF 207 Economic Analysis
- BCF 102 Contract Performance Management Fundamentals Course
- BCF 203 Intermediate Contract Performance Management Course

B.17.4. Developmental Path: TBD.

B.17.5. Training or Work Assignments Comprising Development Path: TBD.

B.17.6. Sustainment to Maintain Expertise: TBD.

B.18. Specific Skill: System Architecture

B.18.1. Description of Skill: TBD.

B.18.2. Basic/Minimum Knowledge: TBD.

B.18.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

B.18.4. Developmental Path: TBD.

B.18.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.18.6. Sustainment to Maintain Expertise: TBD.

B.19. Specific Skill: System Engineering

B.19.1. Description of Skill: TBD.

B.19.2. Basic/Minimum Knowledge: TBD.

B.19.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

B.19.4. Developmental Path: TBD.

B.19.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.19.6. Sustainment to Maintain Expertise: TBD

B.20. Specific Skill: System Test and Evaluation

B.20.1. Description of Skill: Test and Evaluation is the process by which a system or components are compared against requirements and specifications through testing. T&E is usually conducted to assist in making engineering, programmatic or process decisions, and to reduce the risks associated with the outcome of those decisions. The results are evaluated to assess progress of design, performance, and supportability. Developmental test and evaluation is an engineering tool used to reduce risk throughout the defense acquisition cycle. Operational test and evaluation is the actual or simulated employment, by typical users, of a system under realistic operational conditions.

B.20.2. Basic/Minimum Knowledge:

- Understanding of Acquisition Milestones and Phases
- Understanding of the Program Acquisition Categories: ACAT I, II, III, and IV
- Understanding of the Testing Process in the Acquisition Process
- Knowledge of Test Categories (DT & OT) and classes of tests (PQT, IOT,etc) as defined in AR 73-1
- Familiarization and understanding of the development, coordination, and staffing of the Operational Requirements Document (ORD)
- Familiarization with the following policies, regulations and guides:
  - DoD 5000.1 "Defense Acquisition"
  - AR 70-1 "Army Acquisition Policy"
  - AR 73-1 "Test and Evaluation Policy"
  - DA PAM 73-2 "TEMP Procedures and Guidelines"
  - DA PAM 73-4 "Developmental T&E Guidelines"
  - DA PAM 73-5 "Operational T&E Guidelines"
  - DA PAM 73-7 "Software T&E Guidelines"
  - DoD 5000.2-R "TEMP Mandatory Procedures & Format"
  - DoDD 5000.59 "DoD Modeling and Simulation (M&S) Management"
  - MIL-STD-498 "Software Development and Documentation"
  - DoD VV&A "Recommended Practices Guide" (DMSO)
  - DA Pamphlet 5-11 "Verification, Validation, and Accreditation of Army Models & Simulations
  - MIL-HDBK-781 "Reliability Test Methods, Plans, and Environments for Engineering Development, Qualification, and Production"
  - MIL-HDBK-470A "Designing and Developing Maintainable Products and Systems"
  - MIL-STD-810 "Environmental Test Methods & Guidelines"

- Understanding of Roles/Responsibilities of the following:
  - Operational Test and Evaluation Command (OPTEC)
  - Test and Evaluation Command (TECOM)
  - Operational Evaluation Command (OEC)
  - Test and Experimentation Command (TEXCOM)
  - Evaluation Analysis Center (EAC)
  - Test and Experimentation Command (TEXCOM)
  - Materiel Developer, Combat Developer, Proponent/User

- Understanding of the Test and Evaluation Integrated Product Team (T&E IPT) process (former Test Integration Working Group (TIWG)) and its members's responsibilities
- Understanding of the Test and Evaluation Master Plan (TEMP) process to include preparation, coordination, staffing and approval
- Familiarization and understanding of the Critical Operational Issues and Criteria (COIC) development, staffing, and approval processes
- Basic knowledge of the Test Schedule and Review Committee (TSARC) Process and Five Year Test Program (FYTP) Process
- Understanding of the Computer Resources Life Cycle Management Plan (CRLCMP) development

- Understanding the concept and importance of testing documentation such as Independent Evaluation/Assessment Plans or & Reports, System Evaluation Plan (SEP), System Evaluation Report (SER), Test Design Plan (TDP), Outlined Test Plan (OTP)
- Familiarization with the preparation and coordination of Safety Releases and Safety Confirmations for Testing
- Understanding of Technical Readiness Review (TRR), or Developmental Test Readiness Review (DTRR), Operational Test Readiness Review (OTRR), and Operational Test Readiness Statement (OTRS)
- Understanding of the OPTEC System Team (OST) and its responsibilities
- Basic knowledge of the concept of Modeling & Simulation (M&S) in T&E
- Basic knowledge of the VV&A and IV&V processes

OTHER CONSIDERATIONS:

- Reliability, Availability, and Maintainability testing
- System Safety and Health Hazards assessment
- Electromagnetic (EMI) testing requirements
- MANPRINT evaluation/assessment
- Transportability Testing (if required)
- Environmental Testing (if required)

B.20.3. Training or Work Assignments Contributing to Basic Knowledge:

- ACQ 101 - Fundamentals of Systems Acquisition Management
- TST 101 - Introduction to Acquisition Workforce Test and Evaluation
- TST 202 - Intermediate Test and Evaluation
- TST 301 - Advanced Test and Evaluation
- SAM 201 - Software Acquisition Management
- Fundamentals of T&E Process, 3-day Intensive Course sponsored by ITEA
- R&M Testing and RAM Requirements – 80 hrs each at AMEC

- Assign new employee to support a “senior” Project Engineer that is currently working or has previously worked a Test Program for a STRICOM program
- Assign new employee to support a “senior” Project Engineer that is currently developing or has previously developed a TEMP for a STRICOM program, or that is coordinating a T&E IPT
- Allow new employee to attend T&E IPTs (former TIWG)
- Allow new employee to visit government test facilities such as Aberdeen Test Center so he can learn about what test facilites are available and that can be used to support our programs test requirements
- Allow new employee to participate as an observer , i.e., monitor a technical test being conducted at ATC (or contractor’s plant), or an operational test being conducted at, for example, Ft. Hood, so he can learn about test coordination and execution with government and contractor test personnel
- Allow employee to attend/participate in a R-DEMO, M-DEMO, and/or Environmental testing being conducted in another STRICOM program.

- If employee has no experience in acquisition, recommend to begin with ACQ 101 course, otherwise, begin with TST 101 course
- Internal training for employee to familiarize with AR 70-1, AR 73-1, DA PAMs 73-2, 73-4, 73-5, 73-7, DoD 5000.2-R, MIL-STD-498, MIL-HDBK-781, MIL-HDBK-470A, MIL-STD-810, and DA PAM 5-11
- Assign employee to work with (help) a Senior Project Engineer in the areas of T&E
- Employee must attend the RAM Requirements and R&M Testing courses at AMEC
- Continue training with TST 202 & 301 courses
- If employee can’t attend the TST courses (i.e., no slots available) then send employee to the 3-day Intensive Course sponsored by ITEA
- Recommend employee attend the SAM 201 software course

- Assign employee to work his own STRICOM project/program in the areas of System Test and Evaluation
- Supervisor should facilitate employee with additional training as necessary

B.20.4. Developmental Path: TBD.

B.20.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.20.6. Sustainment to Maintain Expertise: TBD.

B.21. Specific Skill: Systems Integration

B.21.1. Description of Skill: TBD.

B.21.2. Basic/Minimum Knowledge: TBD.

B.21.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

B.21.4. Developmental Path: TBD.

B.21.5. Training or Work Assignments Comprising Developmental Path: TBD.

B.21.6. Sustainment to Maintain Expertise: TBD.

Appendix C

Software Engineering Specific Skills

C.1. Specific Skill: Object Oriented Technology

C.1.1. Description of Skill: TBD.

C.1.2. Basic/Minimum Knowledge: TBD.

C.1.3. Training or Work Assignment Contributing to Basic Knowledge: TBD.

C.1.4. Developmental Path: TBD.

C.1.5. Training or Work Assignments Comprising Developmental Path: TBD.

C.1.6. Sustainment to Maintain Expertise: TBD.

C.2. Specific Skill: Operating Systems (OS)

C.2.1. Description of Skill:

It is believed that if an Engineer is to be successful in Operating Systems or Programming Languages that they must have significant knowledge of the other associated skill. Therefore the two skills (Operating Systems or Programming Languages) are treated as one skill set. The engineer shall have a working knowledge of modern Operating System concepts, principles and implementations for the commonly utilized computer systems in the modeling and simulation domain. Skill emphasis is on having a broad understanding of the various aspects of Operating Systems as well as a user-level ability to perform fundamental computer system tasks.

C.2.2. Basic/Minimum Knowledge:

- What is a Portable Operating System Interface for Computer Environments (POSIX) compliant OS
- What is meant by the term: 16-bit, 32-bit, 64-bit OS
- What is meant by the term multiprogramming
- OS Development Scheduling
- Schemes for non-real-time Operating Systems
- Schemes for real-time Operating Systems/applications
- Thread states: running, blocked, & ready
- Preemptive versus non-preemptive
- Differences between Unix, Win95, & WinNT
- Relationship between threads and processes
- Thread/process priority
- Asymmetric vs. symmetric multiprocessing (SMP)
- To what level do Win95, Win98, WinNT, LINUX, and Unix types of Operating Systems support multiple processors
- Virtual memory
- Methods available for processes to share data (shared memory, …..)
- Dynamic-link libraries (Win95/NT): define; describe pro's and con's
- How operating systems address error handling
- OS File systems operation
- Purpose and usage of OS
- Impact of block-size on storage capacity; performance
- Largest file size for various Operating Systems
- Access restriction features of various Operating Systems
- Swap space
- Screen Interfaces
- Command Line Interfaces

- Graphical User Interfaces (Windows, X-Windows/Motif)
- Daemons
- User-level and root/administrator level accounts and uses of each

C.2.3. Training or Work Assignments Contributing to Basic Knowledge:

- Various training classes on Operating Systems (Entry Level) to gain familiarity with each Operating System
- Training in theory/concepts of Operating Systems (Theory behind Operating Systems. Not tied to a specific Operating System)

C.2.4. Developmental Path:

Continued Training in various Operating Systems to gain specific/detailed knowledge of various Operating Systems. (This will also help in determining which Operating System may be the best choice for a specific application/project.)

C.2.5. Training or Work Assignments Comprising Developmental Path: TBD.

C.2.6. Sustainment to Maintain Expertise:

- Training (Hands on preferred) to keep up with new versions/changes in various Operating Systems along with any new Operating Systems that may arise.
- Knowledge sustainment: At least 30-min per week of reading to keep up with new changes and continued learning of other Operating Systems.
- Ability sustainment: At least one 1-hour hands-on session per month to gain expertise/experience in using Operating Systems (not just theory).

C.3. Specific Skill: Programming Languages (PL)

C.3.1. Description of Skill:

It is believed that if an Engineer is to be successful in Operating Systems or Programming Languages that they must have significant knowledge of the other associated skill. Therefore the two skills (Operating Systems or Programming Languages) are treated as one skill set. The engineer shall have a working knowledge of modern standardized Programming Languages. The engineer should know concepts, principles and implementations for the commonly utilized Programming Languages in the training, modeling and simulation domain. Skill emphasis is on having a broad understanding of the various aspects of Programming Languages and the differences/advantages between them. As the military increases their reliance on computing resources to dominate the battlefield of the future, engineers engaged in the development of all types of military equipment must increase their knowledge of software programming languages and the impact these languages can have on the success of their project.

C.3.2. Basic/Minimum Knowledge:

- Understand the need for a diverse set of software programming languages to solve computational problems.
- Understand the use of a software development metrics program and technical documentation (i.e. trade studies) to support software programming language selection.
- Understand the impact of software programming languages on a project's level of effort, costs, staffing and training requirements.
- Understand the advantages and disadvantages (strengths and weaknesses) of different software programming languages.
- Knowledge of COTS (commercial-off-the-shelf) software, re-use driven approaches, certifications (ISO 9001 and SEI capability maturity model), and reengineering.
- Must possess the skills, knowledge and abilities to advise, assist, inform and educate the other members of a project team in all matters related to programming languages.
- Ability to communicate clearly, in non-technical terms, in oral and written form, on matters related to programming language selection, impacts, issues and recommended solutions.
- Ability to review and understand software code.
- Ability to review and understand technical papers and documentation (i.e. trade studies, CDRLs) related to programming languages.
- Ability to assess the impact of software programming languages on a project's level of effort costs, staffing, and training requirements.
- Ability to discuss the advantages and disadvantages (strengths and weaknesses) of different software programming languages.
- Knowledge of resources and available assets related to programming languages.

C.3.3. Training or Work Assignments Contributing to Basic Knowledge:

- Demonstrate the ability to read and understand software code written in two software programming languages.
- Prepare a brief synopsis of what a software program (or part of a program) does during its execution.
- Ability to identify key areas and constructs within the software code.

- Explain how choices of programming language tools affect the level of effort and cost of software projects.

C.3.4. Developmental Path:

- A one or two semester sequence in fundamental programming concepts including common data processing algorithms, constructs and data structures found in most programming languages.
- A one or two semester sequence in a particular standardized programming language focusing on implementing the common data processing elements above utilizing the syntax and semantics of the language. This course should include the use of software engineering tools.
- A one semester sequence in a second programming language focusing on the syntax and semantics of the language. This course should include the use of software engineering tools.
- A one semester sequence in an advanced programming language topic i.e. language design, compiler construction, tool development.

C.3.5. Training or Work Assignments Comprising Developmental Path:

- Initial assignment to a project under the mentoring of a senior software engineer for a period of 3-12 months.
- Progressive assignment to projects with increasingly complex software.
- Assignment to projects utilizing any of the programming languages studied or utilizing a combination of the languages studied.
- Assignment as a mentor to a junior software engineer on a software intensive project.

C.3.6. Sustainment to Maintain Expertise:

- Self-education utilizing CBT, web-based tutorials, and self-study.
- Attendance at a conference discussing programming languages once every 5 years.
- Periodic monitoring of electronic newsgroups and mailing lists dedicated to programming language issues.
- Training in programming languages that the employee does not have prior expertise in.
- Training in development of applications using a standardized programming language (hands-on training/experience.)

C.4. Specific Skill: Software Architecture (SA)

C.4.1. Description of Skill:

- There is no universally accepted standard for software architecture. It is still a developing field in software engineering. A good description of software architecture comes from Bass, Clements, and Kazman. Software Architecture in Practice, Addison-Wesley 1997: which states:

- The software architecture of a program or computing system is the structure or structures of the system, which comprise software components, the externally visible properties of those components, and the relationships among them.

- By "externally visible" properties, we are referring to those assumptions other components can make of a component, such as its provided services, performance characteristics, fault handling, shared resource usage, and so on. The intent of this definition is that a software architecture must abstract away some information from the system (otherwise there is no point looking at the architecture, we are simply viewing the entire system) and yet provide enough information to be a basis for analysis, decision making, and hence risk reduction.

The primary skill is the ability to analyze software architectures to determine the ability to satisfy functional and interface requirements, and to assess the capabilities and tradeoffs for the achievement of qualities such as performance, availability, and survivability. It is cost effective to try to determine, before a system is built, whether it will satisfy its desired qualities. STRICOM software engineers should be able to identify or develop risk mitigation methods that can be done early in the software development life cycle when it is relatively inexpensive to change architectural decisions. It is also important to be able to analyze the architecture of the countless legacy systems in existence. Unfortunately, the architectures of legacy systems are frequently undocumented or existing documentation is inaccurate due to the unavoidable architectural drift and erosion making analysis impossible. Software Engineers should have the necessary skill to reconstruct architectures from source code and to check the conformance of as-built systems to their documented architectures. Software Engineers should possess the skills needed for participating in the development and validation of the technology and techniques necessary for analyzing software architectures, specifically: attribute-specific models, representation approaches, analysis methods, reconstruction and conformance tools and techniques. Software Engineers should be capable of using tools and methods for representing varying views of software architectures.

In summary, Software Engineers who are skilled in SA should be able to:

- Establish, implement, and transition validated techniques for analyzing the effect of software architectural decisions on selected product quality attributes.

- Establish, implement, and transition validated techniques for reconstructing the architecture of legacy systems and for determining the conformance of as-built systems to defined architectures.

- Establish, implement, and transition validated techniques for representing software architectures

- Promote understanding of software architecture and architecture analysis.

C.4.2. Basic/Minimum Knowledge:

- Basic knowledge of what software architecture encompasses.
- Knowledge that any design involves trade-offs. Modifiability affects performance, security affects modifiability, scalability affects reliability, and everything affects cost.
- Prescriptive method implicitly or explicitly assumes that some of these qualities are more important than others do and guides users toward the maximization of that goal.
- Elementary knowledge of techniques used for designing, building, and evaluating software architectures.

- Software architecture is the development product that gives the highest return on investment with respect to quality, schedule, and cost.

C.4.3. Training or Work Assignments Contributing to Basic Knowledge:

- The employee should have the opportunity to work on a software intensive project to gain experience working with a real world software architect and dealing with all of the issues that accompany managing the development effort.
- There are numerous Software Architecture Publications that possess information that will give the employee basic knowledge of software architecture and the importance a well designed architecture plays in a development project. (The SEI website has a list of publications dealing with software architectures.)
- SEI has a good series of slides that describe software architecture. It is called: “What is Software Architecture? And Why Do I Care?". It can be downloaded (Postscript file, can be viewed with Ghostscript) at: ftp://ftp.sei.cmu.edu/pub/sati/Papers_and_Abstracts/what_is_sw_arch.slides.ps
- Attending SAM 101 and SAM 201 Defense Acquisition University Courses will give the employee basic knowledge of software architectures along with numerous other software related topics.

C.4.4. Developmental Path:

- Skills needed to be proficient in the area of Software Architectures:
  - All of the above mentioned skills and abilities.
  - Knowledge that reusable components are best achieved within an architectural context. But components are not the only artifacts that can be reused. Reuse of architecture leads to the creation of families of similar systems, which in turn leads to new organizational structures.
- Comprehensive knowledge of sets of techniques for designing, building, and evaluating software architectures.
- Understand techniques for quality requirements in the context of an architecture and for building architectures that meet these quality requirements.
- Knowledge of architecture description languages as a means of describing and validating software architectures and techniques for analyzing and evaluating an architecture’s fitness for its purpose.
- Knowledge of a number of different architectural tools (layering, multiple views, patterns, blackboards, and so forth) and techniques (analysis methods, integration strategies, engineering principles).

C.4.5. Training or Work Assignments Comprising Developmental Path:

- The employee should have experience as the software engineer on a large software intensive system to gain experience with managing a program dealing with a large software architecture.
- The employee can gain more extensive knowledge of software architectures by reading many, more advanced publications dealing with software architectures. SEI has a good website with a list of many of these publications. It can be found at: http://www.sei.cmu.edu/architecture/projects.html
- Attending the Advanced Software Acquisition Management (SAM 301) Defense Acquisition University Course will give the employee information on software architectures along with program management from a software prospective.

- Attend Events (Conferences, Workshops, etc.) dealing with Software Architectures to discuss software architecture issues with colleagues. This will give the employee up to date information on software architecture knowledge and practices along with lessons learned from real world projects. A web address showing various Events concerning Software Architectures is at: http://www.sei.cmu.edu/architecture/events.html

C.4.6. Sustainment to Maintain Expertise: The field of Software Architecture is still developing and therefore is very dynamic. To maintain a level of expertise, the employee must keep up with the latest developments in tools and techniques dealing with software architectures. This can be accomplished by keeping up to date with new publications dealing with software architectures. Also, attending numerous events dealing with new concepts in the area of software architectures will give the employee an up to date view of what is happening in the field of software architectures.

C.5. Specific Skill: Software Configuration Management (SCM)

C.5.1. Description of Skill: SCM is the application of technical, administrative and surveillance effort to gather and maintain the functional and physical baseline of a software item, (Configuration Control), and to record and report change processing and implementation status (Configuration Status Accounting). It also includes supporting periodic quality assurance/technical reviews and audits (Configuration Audits).

C.5.2. Basic/Minimum Knowledge:
- Understand basic SCM practices and be able to implement establish SCM policies.
- Change control methods/procedures such as configuration control boards (CCBs) and the documentation necessary to support.
- Be organized and be proficient in using the CM tools.

C.5.3. Training or work Assignments Contributing to Basic Knowledge:
- Attendance at seminars/workshops on the latest CM methods and tools.
- Proficient in Personal Computer, Database, Data-Mining and Data Management.
- DAU courses to include: LOG 101

C.5.4. Developmental Path:
- Establish or maintain SCM database for rapid/seamless input and retrieval of data.
- Establish and implement STRICOM-wise SCM process and procedure.
- DAU courses to include LOG 201, 203, and 204

C.5.5. Training or Work Assignments Comprising Developmental Path: TBD.

C.5.6. Sustainment to Maintain Expertise:
- Provide periodical refinement of the SCM methods, process, procedure and products to meet/exceed the demands of STRICOM users.
- Joint Logistics Command courses on CM and Practical Software Management.

C.6. Specific Skill: Software Cost Estimation (SCE)

C.6.1. Description of Skill: Despite the terminology, software cost does not refer directly to the dollar figure associated with software development. Software Cost Estimation (SCE) consists of the following three elements:

- Manpower loading is the number of engineering and management effort personnel allocated to the project as a function of time.
- Effort is defined as the engineering and management effort required to complete a project, usually measured in units such as person-months. The types and the levels of skills for the resources will come into play here.
- Duration is the amount of time (usually measured in months) required to complete the project. A SCE process is the set of techniques and procedures that an organization uses to arrive at a software cost estimate. Generally there is a set of inputs to the process (e.g., system requirements) and an output of effort, manpower loading, and/or duration. The knowledge of how much each of the above elements influences the SCE process output will influence the final cost estimate figure. Deciding which factors to include and combining then to arrive at the estimate make up the software cost estimation process.

C.6.2. Basic/Minimum Knowledge:

- Understand the advantages and disadvantages of different software development cost and schedule estimation methods.
- Use of a software development metrics program to support estimation
- Understand the importance of new costing concepts and paradigms
- Knowledge of COTS (commercial-off-the-shelf) software, re-use driven approaches, certifications (ISO 9001 and SEI capability maturity model), and reengineering

C.6.3. Training or Work Assignments Contributing to Basic Knowledge:

The work assignments related to this skill are: assignment to a development al project as an assistant software engineer for the gathering of requirements and cost coordination in contract negotiation, assignment of to a fielded system for CCB support and estimation of maintenance and sustainment costs for a major training system that is currently used in the field. Training should include courses at the local University level and industry provided training that is general enough in nature to cove the major elements of SCE.

C.6.4. Developmental Path: Through participation in such activities as a Requirements Analysis phase, the engineer will be able to understand the scope of the program from its infancy. Then he/she will use this information along with the other factors listed above (manpower, effort and duration) to calculate the effort required to complete the program using some sort of computer model such as the Constructive Cost Model (COCOMO) . This information will aid the engineer during activities such as a Source Selection Board to make an informed decision on all the bidders proposals.

A formal approach would include taking the following DAU courses:

- BCF 101 – Basics of Cost Analysis - Fundamentals of Cost Analysis enables DOD personnel new to the cost estimating field to prepare materiel system life cycle cost estimates. The course covers DOD policies governing these estimates and the techniques used in their preparation.Topics include a statistics review, regression analysis, learning curves, risk analysis, software cost estimating, exploratory data analysis, inflation adjustments, cost as an independent variable (CAIV), analysis of alternatives (AOA), contract cost structure, earned value, cost estimation for budget preparation, and economic analysis. Students apply the techniques they learn in a series of case studies.

- BCF 206 – Cost Risk Analysis- Cost Risk Analysis prepares cost analysts to model the cost risk associated with a defense acquisition program. Topics covered include basic probability concepts, subjective probability assessment, goodness-of-fit testing, basic simulation concepts, and spreadsheet-based simulation. Practical exercises, a small-group workshop, and a capstone article review reinforce techniques taught.

- BCF 208 – Software Cost Estimating - Software Cost Estimating is primarily for practitioners of software cost estimating. The course is designed for cost analysts and others whose duties should include estimating the cost of software development efforts or reviewing such estimates. Topics in the course include software life cycle management, architecture, interoperability, software development paradigms, software design approaches, metrics, capability evaluations, risk analysis, software reuse, open systems, function points, and software cost estimating models. Two software cost estimating case studies allow students to apply the course material.

C.6.5. Training or Work Assignments Comprising Developmental Path: The software engineer should lead increasingly complex software intensive engineering efforts for programs and should develop SCE packages based on knowledge from the formal training packages. The SCE should know how to use and present concepts resident in CASE tool packages which measure and analyze SCE concepts and to work with contract personnel to insure the best development methods are being used for cost-benefit requirements. The SCE engineer should use or create briefing/review material which describes methodologies and provides engineering input data for program directors decision making process.

C.6.6. Sustainment to Maintain Expertise: The SCE engineer must learn and operate the latest versions of software estimating tools like COCOMO. Attend conferences/symposiums, which provide the engineer with knowledge of the latest information available in SCE analysis. Maintain proficient in SCE methodologies by membership in professional organizations such as INCOSE and IEEE and to read technical journals and publications concerning SCE and participate in technical conferences and presenting papers at professional organizations meetings for review by peers.

C.7. Specific Skill: Software Development and Support Process (SDSP)

C.7.1. Description of Skill: Provides a focused approach for development of a software product. Performs the role of integrating the technical disciplines to achieve the customer's objectives. Provides process definition and improvement in all areas of software development, including: Requirements Management, Project Planning and Tracking, Project Estimation, Software Quality Assurance, Functional and Design Specification, Configuration Management, Testing, Change Management, Verification and Validation Efforts, and Post Deployment Support.

C.7.2. Basic/Minimum Knowledge: Basic knowledge includes the following capabilities:

- Ability to listen and learn (not be a bag of hot air)
- Ability to give credit where credit is due and not always seek one's own credit
- Ability to do hands on work
- Ability to work in a team
- Patience in dealing with other organizations to foster cooperation
- Capability to Analyze Candidate Software Solutions
- Ensure Software Quality
- Familiarity with CASE Tools and Programming
- Domain Expertise
- Coordinate with Contractors and Customer
- Derive and Allocate Software Requirements
- Manage Software Configurations
- Participate in Definition of Organization's Software Engineering Process
- Evolve Software Architecture
- Manage Risk Integrate Disciplines
- Monitor and Control Software Technical Effort
- Manage Software Product Line Evolution
- Integrate Software
- Plan Software Technical Effort
- Manage Software Engineering Support Environment
- Understand Customer Needs and Expectations
- Provide Ongoing Knowledge and Skills in Simulation Domain
- Verify and Validate System
- Coordinate and Participate in Software Testing

C.7.3. Training or Work Assignments Contributing to Basic Knowledge:

Training should include participation in professional organizations such as SISO, IEEE, I/ITSEC and other organizations that deal in the SDSP. SEI and other industrial organizations and associations provide a great deal of SDSP related conferences and symposia for development of these skills. Training provided by contractors that are prime on major command projects is a very good source of instructional material. University courses from computer science departments on initial development and logistics support are valuable. Courses in Software Logistics Support are being offered in the industrial engineering departments.

Assignment as a Systems/Software Engineer here at STRICOM. Types of assignments are typified by the projects listed below:

- AC-130U Navigator/Fire Control Officer (NAV/FCO) Test Bed
- Close Combat Tactical Trainer (CCTT)
- Federation Test System (FTS)
- Modular Semi-Automated Forces (ModSAF)
- Semi-Automated Forces (SAF)

C.7.4. Developmental Path:
The development path should include duties from initial development through lifecycle support of an item. The developmental path is broken up into 3 sections:

Entry level: At this level the individual should be a part of a developmental item team. The person should be responsible for configuration Control of documentation and ECP items. The engineer should be provided the opportunity to review for completeness the code and the supporting documentation and be provided oversight and guidance in the conclusions offered. The engineer should be given opportunities to brief contractor staff on decisions and actions to be taken. The engineer should be allowed to attend professional meetings and present briefings on project topics.

Mid Level: The engineer should be given the responsibility for the overall vision of the project and provide the PD with the technical aspects of of the project from cradle to grave. They should prepare estimates for cost (manpower) and schedule. They should be responsible for accurate and timely documentation support and should be able to answer issues of both higher command and support contractor support.

SME should be made responsible for overall technical aspects of item lifecycle from development throughout usage. The engineer should be fully aware of all documentation, briefings, issues, ECP and support issues tied with the project. The SME is responsible to the PM for complete knowledge of all technical issues and solutions.

C.7.5. Training or Work Assignments Comprising Developmental Path: The training of the engineer is an on going process. The process is divided into the three levels as depicted above.

The entry-level engineer should take at least one of the following three DAU certification paths: SPRDE (SYS 101), Testing (TST 101) or Logistics (LOG 101). In addition the engineer should take University and Industry instruction in Software Logistics Management, Software Cost Estimation, Development issues and lifecycle support issues. The mid-level engineer should take the next series of DAU courses for certification.

In addition the mid-level engineer should participate in professional organizations which support this effort and also study industrial and government standards on documentation, logistics control and software development CASE tools and evaluations.

The SME must finish at least one certification, and most likely 2. Should have a minimum of a graduate degree in a Software intensive engineering field. The engineer should belong to at least one professional organization e.g. IEEE, SNE, SISO, I/ITSEC, MORES etc. The engineer must maintain professional

competence through seminars, briefings and symposia, which delineate changes and enhancements to the field.

C.7.6. Sustainment to Maintain Expertise: Sustainment of experience is through professional organizations, symposia, conferences and technical meetings. Post Graduate courses, which are directly tied to this area, are encouraged. Briefings and presentations to technical judged symposia and conferences to include process definition organizations such as SPC and SEI. The SME must also be involved in Joint operations projects that involve FMS and joint services agreements.

C.8. Specific Skill: Software Development Methods and Tools (SDMT)

C.8.1. Description of Skill: SDMT covers the traditional waterfall, spiral, and Objected-Oriented Technology modeling, Non-Developmental Items (NDI) to the complete use of COTS to develop a system. The life cycle activities associated with SDMT are similar to system engineering: Requirement definition, design, test, validation and sustainment. There are many different tools and languages supporting different types of process (e.g., waterfall and Object Oriented (OO)) definition (e.g., requirement generation), modeling (e.g., functional & Behavioral), and simulation (e.g., virtual, constructive) and they change as the technology changes.

C.8.2. Basic/Minimum Knowledge: This is a field that one must understand the past SDMT and be able to comprehend the new trends. One should have degree/or working knowledge on Software Development, Acquisition, and software engineering. One must also frequently attend trade-shows, and product demo.

C.8.3. Training or Work Assignments Contributing to Basic Knowledge: DSMC/DAU has several courses lead to certification in Software Acquisition Management. Software Technology Support Center at Hill Air Force Base has an extensive library/topics on SDMAT. There are a lot of lessons learned (undocumented) about the goods and the bad of software acquisition at STRICOM and DOD. There are product demo(s) and trade-shows one can attend all year around. However currently there is no gage or metrics or outlets to measure ones understanding of SDMAT. There needs to be feedback mechanism setup and a well-defined depository to increase the level SDMAT awareness. This will be the task of the SDMT skill lead in the future.

C.8.4. Developmental Path:

a. Entry Level: Be able to identify software development methods to include:
- Choice between evolutionary, incremental, or waterfall development methods
- Choice of SW requirements analysis and design methods (e.g., Data flow oriented, Data structure oriented, Object oriented)
- Software peer review methods
- Coding, unit test, and integration methods

b. Mid-Level: Be able to identify the types of tools used for each development period of the software life cycle:
- Requirements, Analysis, Specification, and Design Tools (e.g., Test Case Analysis and Generation, Graphical Modeling Tools);
- Programming and Debugging Tools and Components (e.g., Ada Compilers and Programming, C/C++ Compilers and Programming Components, CORBA-Related Products, Embedded Systems Development, Java Programming);
- Testing and Test Management Tools
- Database Design and Development Tools
- World Wide Web Development Tools (e.g., Java Programming Environments Web Page and Site Editors) **Note—C4I Systems currently utilized web pages.
- Project, Process, and Product Management Tools (e.g., Configuration Management and Version Control Problem Tracking Systems)
- Rapid Application Development Tools
- Middleware and Connectivity Products (e.g., CORBA-related Products)
- Other Tool Categories (e.g., GUI Builders, Program Analysis and Metrics, Frameworks and Integrated Environments, Simulation, License Management)

c. Subject Matter Expert: Be able to identify the type of tools used based upon the system modeling approach required (e.g., state machine, virtual – constant delta time intervals, constructive -- time stepped, irregular intervals)

C.8.5. Training or Work Assignments Comprising Developmental Path:

- Attend in-house sponsored courses (e.g., Introduction to Object-Oriented Technologies for Engineers by Software Productivity Consortium)
- DAU courses to include:
  - Entry Level: SYS 201. SAM101.
  - Mid Level: SYS 301, SYS 211, SAM 201.
  - SME Level: SAM 301
- Attend university courses
- Attend short contractor sponsored courses
- Assignment to a virtual simulation project
- Assignment to a constructive simulation project
- Assignment to a C4I project
- Assignment to research efforts

C.8.6. Sustainment to Maintain Expertise:

- Ongoing personal web research and reading (e.g., Index of Software Development Methods and Tools http://www.methods-tools.com/html/tools.html)
- Attend professional meetings and conferences (e.g., Software Technology Conference)

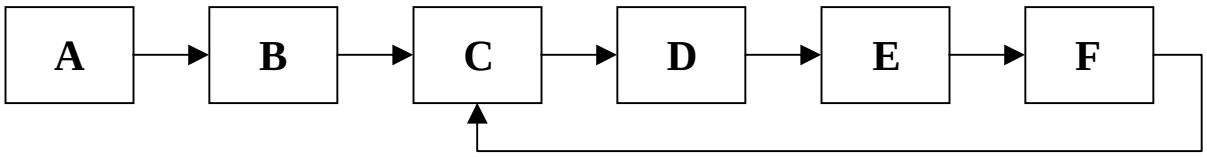
C.9. Specific Skill: Software Measurements and Analysis (SMA)

C.9.1. Description of Skill:

This skill focuses on data-driven decision making. This data-driven decision making is based on a measurement program that provides information that improves decision-making in time to affect the outcome of the process and/or project. A measurement program can: (1) Provide early insight into program risks and potential problems, (2) Provide quantitative support for management decision making, (3) Help forecast trends, (4) Provide visual indicators of progress, (5) Correlate diverse data and trends, and (6) Track effectiveness of corrective actions. A measurement program can not: (1) Fix a problem or eliminate risk, (2) Identify the solution to a problem, (3) Guarantee product quality, or that the product meets mission goals.

C.9.2. Basic/Minimum Knowledge:

This skill requires a framework to be able to establish a measurement program for a given project or an organization. The following is a description of a framework (or process) for adopting software measurement in an organization/project.



A – ESTABLISH A SUPPORTIVE CULTURE. The purpose of this task is to ensure there is management sponsorship for the adoption of software measurement technologies. Following are tasks to establish a supportive culture:

- Understand the organization's mission and goals
- Establish (or develop) sponsorship for adopting software measurement
- Establish measurement roles and accountability at all levels of the organization

The more significant elements of a supportive culture include:

- Proactive leadership
- Supportive management style
- Open organizational communications
- Quality-oriented work environment

B – DETERMINE CURRENT MEASUREMENT CAPABILITY AND USE. The purpose of this task is to determine how well an organization is using measures and how ready it is for additional technology adoption. The steps for determine the current measurement capabilities include:

- Examine (or evaluate) current use of software measures.

Examine underlying organizational readiness to implement software measurement.

Determine current information needs, including project progress, product quality, and process effectiveness.

There are two factors that make the difference in this area to support and effective measurement program. The following two factors are additive to the factors noted above.

- Educated management expectations.
- Effective organizational infrastructure.

C – DEVELOP ORGANIZATION'S MEASUREMENT PLAN. The purpose of this task is to develop a plan to adopt software measurement. This plan is like any project plan because the adoption of technology by an organization must be managed like any other project the organization would undertake. In other words, develop a project plan that will:

- Establish goals and measurable objectives
- Identify risks and mitigation activities
- Identify measurement adoption tasks
- Identify the organization's needs for education and training
- Establish resources and budget requirements to meet objectives
- Define milestones and schedules for implementation
- Gain support for and approval of the plan across the organization

The goals of the project planning are to:

- Establish specific objectives – goals, quotas, or target.
- Define high-level requirements of a statement of work
- Define a realizable, measurable approach to meeting those objectives – actions and strategies to follow
- Risk management – identification of risks, probabilities of occurrence, and mitigation steps
- Establish cost and schedule baselines – time, people, other resources
- Set and manage expectations

D – DEFINE AND USE SOFTWARE METRICS. The purpose of this task is to execute the software measurement adoption plan. The goal is to see the results of measurement in action within the organization.

- Execute the plan
- Define needed information and data that fulfill the information needs
- Define software measures to provide needed information
- Ensure the measures support organizational objectives
- Implement the defined measures in pilot projects
- Evaluate progress against plan
- Provide education and training, keyed to your organization, to support software measurement

E – EVALUATE RESULTS. The purpose of this task is to determine how well the initial measurement objectives have been met and to establish a motivation to refine and improve the measurement program over time. The steps are to:

- Determine whether the organization reached the goals and objectives stated in the plan
- Determine whether some goals are unfulfilled
- Establish how the current software measures support objective “data-driven decision making.” For example,
- Has a project performance baseline been established?
- Are historical data kept to help predict the organization’s performance on new projects?
- Establish new measurement goals the organization needs to fulfill. For example,
- What decisions are still being made without data to support them?
- What questions need to be answered using objective means?

F – DETERMINE ON-GOING NEEDS. The purpose of this task is to provide the foundation to evolve measurement implementation within the organization. Following are questions to be answered to gain insight into the ongoing measurement needs for the organization:

- Is there support to continue work on the measurement goals left unfulfilled?
- Do the current measures show how well the organization is meeting its objectives?
- Do the current measures provide the information needed to support management decisions?
- Do new goals support the organization’s mission?
- Does ongoing measurement implementation and refinement have a sponsor?
- Who is accountable for implementing and using software measurement to fulfill the new goals?

C.9.3. Training or Work Assignments Contributing to Basic Knowledge:

This skill should have familiarity with the following DOD software measurement initiatives:

- Practical Software Measurement (PSM), Joint Logistics Command, Software Productivity Solutions, Inc.
- U.S. Army Software Metrics / Software Test & Evaluation Panel (STEP) Metrics, DA PAM 73-7, Chapter 10, 15 Jul 96 (pre-publication).

C.9.4. Developmental Path: TBD.

C.9.5. Training or Work Assignments Comprising Developmental Path: TBD.

C.9.6. Sustainment to Maintain Expertise: TBD.

C.10. Specific Skill: Software Quality Assurance (SQA)

C.10.1. Description of Skill: SQA is a special discipline of the overall QA effort. SQA is a planned and systematic pattern of all actions necessary to provide confidence that software is adequately developed, tested and supported throughout its life cycle by:

- Establish checkpoints and procedures to validate, and verify software activities of others
- Create products and services that conform to the established software quality requirements and common recognized practices

SQA activities involve administrative and technical work concerned with monitoring, controlling and maintaining the quality and reliability of hardware, software, integration, services or processes. A person that normally assigned to this task ensure that program software quality aspects are adequately considered in pre-award (i.e., software development plan), design reviews (i.e., code walkthrough), configuration audits (i.e., physical and functional), quality management system audits (i.e., metrics reporting), production readiness reviews (i.e., checkout), etc

C.10.2. Basic/Minimum Knowledge:

- Has strong math background and analytical ability.
- Has keen observation and trouble-shooting skills.
- Ability to review software code.
- Proficient in the use of software development tools to gain visibility into the software development process.
- Capable of establish monitoring and control activities (i.e., metrics) and reporting findings through an independent chain of command.
- Understand the various types of specification requirements and design parameters involved in software development, and testing. Understand related quality assurance policy, procedures and responsibilities and their implementation. Resolve issues without provoking resentment relating to software processing and maintaining a set of standardization documents to document software development progress.

C.10.3. Training or Work Assignments Contributing to Basic Knowledge:

- Courses in programming language(s), a degree in computer engineering or advanced mathematical /statistical field. Two introductory courses taught by the Joint Logistics Commanders, Joint Group on Systems Engineering includes PSM and Risk Management. Other courses will be added as they are developed.
- Attend workshops, seminars, or conferences focusing on SQA. These include the SISO conference, The ITSEC conference and other vendor and corporate conferences as available.
- Courses in maximize Rate-of – Returns by implementing SQA.
- DAU courses for entry-level applications include PQM 101,103, and 104.

C.10.4. Development Path:

Currently there is no standard SQA expertise/function existed at STRICOM. Activities need to establish the mid-level development activities are:

- Establish or assist in the establishment of the SQA function at STRICOM.
- Establish or implement SQA functions as part of the overall software development process at STRICOM.

C.10.5. Training or Work Assignments Comprising Developmental Path:

- Job assignment at Contractor's plant working with the DCMC personnel.
- Job assignment at other MACOM where SQA organization is still part of the infrastructure.
- Mid level DAU courses include: PQM 201,202,203

C.10.6. Sustainment to Maintain Expertise:

- Present findings on the benefits of SQA.
- Serve as the SME on the subject of SQA.
- DAU course PQM 301 and certification in the PQM arena

C.11. Specific Skill: Software Requirements Analysis (SRA)

C.11.1. Description of Skill: Software Requirements Analysis (SRA) is the translation of user needs into a complete set of quantifiable, measurable, and testable software requirements; i.e., what the system software must do considering the environment in which it is to operate. Thorough requirements analysis includes a comprehensive cost/benefit analysis, an estimate of the resources required to develop, operate, and maintain the software, and regulatory or policy controls that affect software development and operation. Requirements baselined during the SRA phase are the basis for subsequent testing activities, which determine whether a requirement has been correctly interpreted and implemented. The Software Requirements should be testable. Ideally, if the contract and schedule allow, some overlap between requirements and design phases should be allowed.
The product of this phase is a set of control and data flows, supplementary text, and graphic materials that fully describe the functions the software must perform, including specific algorithms and step-by-step processing. Traceability between SRA products and specific user requirements (typically in the System Specification) should be documented. One product is the Software Requirements Specification, which contains the Software Requirements. The traceability between system requirements and software requirements is essential.
The analysis and definition of software requirements is the most important, yet difficult phase of any software development. If done improperly, the impact can be devastating, and resulting system deficiencies may be difficult, if not impossible, to correct. If done correctly, this phase will save lots of time in design.

C.11.2. Basic/Minimum Knowledge:
- Familiarity with various structured analysis techniques including:
- Functional decomposition
- Hierarchy diagrams
- Object-oriented analysis
- Data flow analysis
- State transition charts
- Familiarity with the following software development methods which provide views of the system from different perspectives:
- Object-Oriented
- Process-Oriented
- Behavior-Oriented
- Familiarity with Domain Engineering and Software Reuse concepts
- Ability to evaluate and use CASE Tools to support SRA
- Strong communication skills are needed to ensure understanding of user needs
- Familiarity with one or more high level programming language
- Knowledge of System Engineering concepts commensurate with the GS-854-13 level
- Knowledge of the importance of interface definition between software components. For example, what data does one software component expect to get from another? If one component changes, who needs to know?

C.11.3. Training or Work Assignments Contributing to Basic Knowledge:
- System Engineering Training (that emphasizes Software Intensive systems)
- Basic Army 101 courses (for example C4I principles) to better understand user requirements

C.11.4. Developmental Path:
- BS Degree in Computer, Electrical, or Software Engineering
- DAU Courses, Software Acquisition Management, SAM 101, 201, and 301
- DAU Courses, SYS 201 and SYS 301
- MS Degree in Software or Computer Engineering
- Rotational or Training With Industry Assignment on a development project during SRA phase

C.11.5. Training or Work Assignments Comprising Developmental Path:

- Assignment to multiple software intensive projects in the requirements analysis phase
- Complete Software Engineering related courses

C.11.6. Sustainment to Maintain Expertise:

- Completing Software Engineering related University Courses
- Attending Industry Conferences and Symposiums
- Periodically attending training on new Tools and Methodologies
- Participation in the SRA phase of a STRICOM project

C.12. Specific Skill: Software Resource Estimation (SRE)

C.12.1. Description of Skill: The skill of Software (SW) Resource Estimation (SRE) is one of many keys to successful project management. SRE encompasses the need to accurately estimate the expected effort needed, to complete a project's software development effort IAW proposed completion dates. The esoteric nature of SRE stems from the fact that most (if not all) cost-estimated techniques are based upon past experiences. These experiences include those of the estimator as well as past performance of a contractor captured by collection of quantitative data from there past projects. Analysis of this collected quantitative data entails being able to estimate and analyze software metrics of resources. These metrics can include estimates of the software development efforts - size, expected manpower needs; cost; and progress in meeting programmatic milestone/schedule dates.

C.12.2. Basic/Minimum Knowledge: An understanding of structured development and an understanding of object-oriented development methodologies. An understanding of developmental concerns and cost drivers to include:

- Requirements creep coupled with unrealistic expectations;
- Incorporation of rapid prototyping/feature development methodologies and concerns
- Positive effect of OOD methodologies;
- Noncoding tasks such as CM/QA, Test Interface control, and documentation taking time and money to complete;
- Need to rethink the design due to changes in operation requirements;
- Over optimistic schedules for alpha and beta testing;
- Need to use project management software for estimation of task completion times for each task; identifying critical paths; and establishing final dates.

A development cycle must specify, design, prototype, review, implement, and test - should be established. Basic knowledge required should include the ability to identify which metrics are being used on a program; consider their influence and impact; determine whether they help predict time or quality of development. Should be able to identify irrelevant metrics while adopting appropriate ones. Should be able to look at system requirements, and contractor proposal or metrics report, and estimate the software resources required for the project, including software size, manpower, cost, and progress.

Cost and Schedule Estimation Techniques that are required include:

- Time for analysis, design, implementation, and testing;
- Hierarchy metrics, including nesting level, number of abstract classes, "fanout
- Methods metrics, including size (in lines of code) and number of parameters;
- Coupling and cohesion metrics;
- Reuse metrics.

Advanced Knowledge:
The following is a list of a number of cost estimates commonly included in discussions of general software engineering cost models.

- Algorithmic Models, including algorithms for producing a software cost estimate e.g. COCOMO;
- Rules of Thumb, including guidelines that have evolved within the software engineering community over time
- Expert Judgement, including consultation with one or more experts;
- Estimation by Analogy, including comparisons with completed projects;
- Design to Cost, including matching the product to the effort (cost) available;
- Price-to-Win Estimating;
- Top-Down Estimating;
- Bottom-Up Estimating.

C.12.3 Training or Work Assignments Contributing to Basic Knowledge: The entry-level person must have a BS Degree in Computer Science, Electrical/Electronic, or Software Engineering. The entry level person must persue the following training to progress to the mid level status:

- DAU courses in Software Acquisition Management to include SAM 101and SYS 201
- Graduate courses in Industrial Engineering (interactive Simulation), computer science or engineering, training with industry, system engineering training with emphasis on software intensive systems and/or use of cost estimation and other CASE tools for systems' development.

C.12.4. Developmental Path:

- Masters. Degree in Industrial Engineering (Interactive Simulation) or Computer Science/Engineering.

Rotational or Training with Industry Assignment on a development project during SRA phase.

- DAU Courses, Software Acquisition Management, SAM 201.
- DAU Courses, SYS 301.
- Cost Estimation training and further development in CASE tool usage.
- System Engineering training that emphasizes software intensive systems.
- Basic Army Information Assurance (IA) and Automated/Computer Systems courses.
- Be assigned on a proposal evaluation team, to be exposed to how the contractor estimated its required resources.
- IBR (Integrated Baseline Review) training, to learn earned value cost and schedule metrics.
- Study previous SW metrics methods. Look at such things as how SLOC was estimated against requirements, and cost against SLOC). Become proficient software size and manpower estimates through study of like systems' requirements.
- Be assigned as the metrics POC on a simulation project.

C.12.5. Training or Work Assignments Comprising Developmental Path: TBD.

C.12.6. Sustainment to Maintain Expertise:

To maintain expertise, I recommend periodic training and assignments as described above. In addition:

- DAU Courses, Software Acquisition Management, SAM 301
- Completing Software Engineering related University Courses
- Attending Industry Conferences and Symposiums
- Attending training on new Tools and Methodologies
- Participation in the SRA phases of STRICOM projects
- Attend project's metrics training. This training gives insight into the contractor's justification and method for SW resource estimation. Participate in the approval process for creation of realistic metrics.
- Participate in symposia and conferences in the creation and acceptance of MOE for systems' effectiveness and acceptance.

C.13. Specific Skill: Software Test Engineering Methods (STEM)

C.13.1. Description of Skill: Knowledge of software requirements traceability, from requirements decomposition, to software documentation, through software verification. Knowledge to include development and requirements of test portion of software development files. Basic knowledge of software development methodologies, software configuration management, and software quality assurance, and their relationship to software testing. Basic knowledge of the Test Incident Report generation, monitoring, and closure process. Knowledge of unit/component/configuration item requirements definition, testing, integration and testing processes and techniques. Means to generate the appropriate test cases, requirements, procedures and expected outcomes. Knowledge of boundary testing and various stress testing techniques (erroneous input, etc). Knowledge of usage of test drivers and stubs within unit/component/CI testing, and their configuration management requirements. Knowledge of automated software-testing tools. In depth knowledge of various testing techniques to include path testing (and path generation/complexity measurements), mutation testing, symbolic execution, state transition testing, transaction flow testing, etc. Knowledge of Integration testing techniques (top-down, bottom-up, big bang, sandwich). Understanding of software metrics and their relationships to software testing (complexity, depth of testing, McCabes, Halstead's, etc).

C.13.2. Basic/Minimum Knowledge:
- Alpha and Beta testing, and their relationship to fielding and the means to track problems through these forms of testing.
- The difference between testing and debugging.
- The differences between host and target software testing and the limitations/concerns of each test type.
- Cold start procedures, value, intent and process, and its relationship to software CI testing.
- Software reliability testing, tools and techniques.
- How to perform software "spare" resource (sizing, timing, etc) testing.
- The various software development techniques (structure design versus object oriented versus real-time systems) and their impacts on testing methodologies.
- The differences between developed software, COTS software, and 4GL software testing and requirements verification.

C.13.3. Training or Work Assignments Contributing to Basic Knowledge:
DAU Courses:
- Basic Software Acquisition Management (SAM 101)
- Introduction to Test and Evaluation (TST 101)

C.13.4. Developmental Path:
Participate in development of software test plans, onsite acceptance testing, and Test Incident Report meetings to get a feel of the STEM process and procedures.

C.13.5. Training or Work Assignments Comprising Developmental Path:
DAU courses:
- Intermediate Software Acquisition Management (SAM 201)
- Intermediate Test and Evaluation (TST 202)

C.13.6. Sustainment to Maintain Expertise:
Attend conferences (ex. Software Technology Conference, ITSEC, CALS) to keep up to date on the latest practices and programs used in software test and evaluation.

C.14. Specific Skill: Trusted Software Development Methodology (TSDM)

C.14.1. Description of Skill: The skill of developing software IAW a Trusted Software Development Methodology (TSDM) requires knowledge of TSDM trust principles as outlined in the July 2, 1993 TSM Report. {Note: This document contains a rationale for each trust principle; a set of compliance requirements for the trust principle as well as identification of applicable trust classes. In addition, the document identifies a list of associated DoD requirements that describe activities similar to those addressed in the trust principle and provides a list of useful references for the trust principle.}

C.14.2. Basic/Minimum Knowledge: The basic knowledge required includes an understanding of security to include factors such as threat, vulnerability, safeguards, and configuration management (CM). The candidate should exhibit familiarity with hardware, software, and firmware that have been shown to be robust and secure enough to support TSDM such as appropriate relational database management systems and operating systems (OS) e.g. Oracle meeting NSA Orange book Levels and Sun Solaris Trusted OS. An understanding of encryption/decryption devices is expected as well as knowledge of appropriate networking hardware items such as routers and switches that have been approved for operation in a collateral environment (supporting operation at multi-echelons of security).
As a minimum, the candidate should understand each of 25 TSDM principles that can be grouped into the following four areas:

- Management Policy (trust principles 1-6);
- Environment Controls (trust principles 7-10);
- Environment Management (trust principles 11-14);
- Software Engineering (trust principles 15-25).

Should understand what discriminates between the five TSDM Levels:

- T1 (minimal trust);
- T2 (moderate trust);
- T3 (preferred);
- T4 (malicious attack);
- T5 (ideal).

Because TSDM is a process to measure software/information assurance (IA), a candidate should be cognizant of the implementation/integration of each of the TSDM 25 principles into a project's general software development process. This means an understanding of the importance that a programs Software Development Plan (SDP) plays in ensuring acceptable TSDM practices are being carried out, is necessary. This is because, the SDP will capture TSDM compliance methods as well as preliminary software engineering team risk analysis results.
Additionally, it is important to understand how TSDM compliance will be identified and tracked using software engineering analysis standards such as the Software Engineering Institutes (SEI) Capability Maturity Model (CMM). Knowledge is required to be able to estimate of the cost associated with providing TSDM training on a program to the software engineering team members. Finally, knowledge of software reuse and metrics collection is necessary.

C.14.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

C.14.4. Developmental Path:

- BS Degree in Computer, Electrical/Electronic, or Software Engineering.
- DAU Courses, Software Acquisition Management, SAM 101, 201, and 301 (entry, Mid, Expert levels respectively).
- DAU Courses, SYS 201 and SYS 301 (mid and Expert levels).
- MS Degree in Industrial Engineering (Interactive Simulation) or Computer Engineering.
- Rotational or Training with Industry Assignment on a development project during SRA phase.
- Cost Estimation training utilizing state of the art CASE tools.
- System Engineering training that emphasizes software intensive systems.
- Basic Army Information Assurance (IA) and Automated/Computer Systems courses.
- Assigned to a proposal evaluation team, to be exposed to how the contractor estimated its required resources.

- IBR (Integrated Baseline Review) training, with emphasis on earned value cost and schedule metrics, like ACWP and BCWP.
- Study previous SW metrics methods. For example, WARSIM is using knowledge obtained from CCTT SW metrics. Look at such things as how they estimated SLOC against requirements, and then cost against SLOC . Review SW size and manpower estimates, both projected and actual.
- Be assigned as the metrics SMS on a simulation project.

C.14.5. Training or Work Assignments Comprising Developmental Path:

- Assignment to multiple software intensive projects in the requirements analysis phase
- Complete Software Engineering related courses

C.14.6. Sustainment to Maintain Expertise:

To maintain expertise, I recommend periodic training and assignments as described above. In addition:

- Complete Software Engineering related University Courses
- Attend Industry Conferences and Symposiums
- Attend training on new Tools and Methodologies
- Participation in the SRA phase of a STRICOM project
- Attend project's metrics training. Which depicts the contractor's justification and method for SW resource estimation.

Appendix D

Synthetic Engineering Specific Skills

D.1. Specific Skill: Artificial Intelligence (AI)/Expert Systems (Knowledge of)

D.1.1. Description of Skill: Skills associated with Artificial Intelligence (AI) include an understanding of the efforts taken to construct mechanisms that perform tasks requiring intelligence. This includes providing to a training systems device, the capability to perform functions normally associated with human intelligence e.g. reasoning, learning, and self-improvement. The AI skill set includes an understanding of how computers, computer related techniques, increase the intellectual capabilities of humans as well as lead to improvements in an individual's perception and identification talents. The AI/Expert System skill set encompasses artificial learning and improvements in techniques of self-organization, self-adaption, self-repair, automatic fault detection, and correction.

D.1.2. Basic/Minimum Knowledge: The basic knowledge required includes having a basic understanding of the fundamentals of AI, which is devoted to creating computer software and hardware that attempts to produce similar results to what could be expected from actual humans. An understanding of how AI is applied in the domains typically encountered during development of a training device (i.e. Expert systems; Robotics and Sensory Systems; Computer Vision and Scene Recognition; Speech (Voice) Understanding; Natural Language Processing; and Intelligent Computer-Aided Instruction), is important. This may include the use of AI/ Expert Systems in a myriad of different industries (i.e. accounting, computer science, decision science, industrial engineering, information systems, public administration, etc). Further knowledge required includes a high level understanding of Symbolic Processing, as AI is a branch of computer science dealing with symbolic, non-algorithmic methods of problem solving. The basic AI/Expert System skill set includes an understanding of: Heuristics (rules-of-thumb); exhibitions of reasoning done by machines which use forms of inference to distinguish facts from rules; Pattern Matching techniques/methods used to describe objects, events, processes in terms of their qualitative features and logical/computational relationships.

D.1.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.1.4. Developmental Path: To aid in the development of this skill, the individual can attend privately operated seminars, courses that typically last one to four days. Active participation in IEEE Computer Society, Robotics Institute of America, Computer Generated Forces (CGF) Conferences, SIGGRAPH, I/ITSEC, SID, SPIE Aerosense conferences as well as reading electronic/printed versions of those society's journals/proceedings develops an individuals skills. Participation in testing of training devices that leverage off of AI/Expert Systems techniques can develop these skills. Mentoring with senior AI/Expert System SMEs provides a developmental path. Attendance at AI/Expert System shell company sponsored training programs develops these skills. Sharing of ideas, participation in HLA, DIS, DIS++ conferences act as vehicles for development of these skills. Assignment on AI/Expert System related Proposal evaluation teams can provide meaningful training.

D.1.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.1.6. Sustainment to Maintain Expertise: TBD.

D.2. Specific Skill: Artificial Intelligence (AI)/Expert Systems (Advanced Knowledge of)

D.2.1. Description of Skill: Advanced knowledge of Artificial Intelligence (AI)/Expert Systems would include an understanding of how AI technologies are implemented during the search and evaluation steps of the problem solving/decision making process. This includes informal approaches (intuition, acting on impulse) as well as formal ones such as optimization (numeric quantitative analysis), blind search [both complete (exhaustive) and incomplete (partial) searches], and the use of heuristics which may involve numeric or qualitative (symbolic) analysis. Advanced AI/Expert System knowledge includes an understanding of how knowledge is represented as rules [expression of the relationships between facts] along with an understanding of how a rule is fired following satisfaction of its premise, yielding a conclusion that can be drawn. Knowledge of meta rules; frames [rules and parameters describing a problem space or an object]; semantic networks [which express relationships among frames]; artificial neural nets; and forward/backward chaining search characteristics, is a necessity.

D.2.2. Basic/Minimum Knowledge: A high level understanding of how AI techniques are incorporated into problem representation, problem solving strategies, pattern analyzation, pattern recognition/matching - along with a realization that advanced knowledge of Expert Systems includes familiarity with rule-based expert systems and methods of knowledge representation. Advanced AI knowledge includes experience using Symbolics machines, programming in LISP or Prolog and knowledge of various Expert System software shells (i.e. Personal Consultant Plus; Personal Consultant Easy; Level Five Object; DM1; Exsys Pro; VP Expert; N Expert Object; GURU; CLISP; G2). Additional knowledge includes use of evaluation criteria to assist in Expert System shell selection. This includes knowledge of goal driven (backward chain), data driven (forward chain) techniques as well as use of inference tree, goal tree, and logical tree techniques. Knowledge of model-based reasoning and case-based reasoning using scripts is needed. Knowledge of futuristic techniques like uncertainty (i.e. Bayesian theory, fuzzy sets, Dempster Shafer Theory, genetic algorithms); chaos theory; fuzzy logic; sensors; neural computing such as artificial neural networks (ANN); speech recognition/synthesis; computer vision, machine vision, robotics (androids, cyborgs) - all encompassing image acquisition, image processing, image analysis, and image understanding/symbolic processing, is a necessity. Finally, the individual should display and understanding of advanced learning techniques (inductive, case-based reasoning and analogical reasoning, ANN, explanation-based, genetic algorithms, statistical methods) and advanced reasoning systems (truth maintenance systems or non-monotonic reasoning, constraint satisfaction, hypothetical reasoning using uncertainty).

D.2.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.2.4. Developmental Path: To achieve and maintain expertise in AI/Expert System development, the individual should take courses such as those offered in UCF Department of Industrial Engineering graduate program in Simulation Systems or Training. Attendance at other academic sponsored forums, seminars, conferences can provide growth to the individuals skills in this domain. Assuming the role of COTR/COR for SBIR or BAA initiatives that encompass or involve some part of the AI/Expert System domain is needed. Periodic training and associated assignments also provide a means to maintain this skill. Assume leadership role on AI related project IPTs.

D.2.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.2.6. Sustainment to Maintain Expertise: TBD.

D.3. Specific Skill: Atmospheric/Oceanographic Representation

D.3.1. Description of Skill: The skills associated with the environmental representation for METOC (Meteorological/Oceanographic) data requires a basic understanding of atmospheric and oceanographic phenomena and their effects upon propagation of signals in various wavelengths. The individual must be able to use this knowledge to analyze training requirements and determine which environmental effects must be implemented in the simulation system and the appropriate level of fidelity required to support the stated training objectives.

D.3.2. Basic/Minimum Knowledge:

- An understanding of representation of static environmental data and the implementation of dynamic environmental effects models and their affects on sensors and behaviors in the simulation's run-time environment.
- An understanding of the various sources, formats and content for METOC source data
- Familiarity with the Master Environmental Library and the models and data sources provided
- An understanding of the processes used to transform source data into correlated, integrated data-sets and the associated static run-time representations
- Familiarity with various environmental effects models and the appropriate levels of fidelity used to represent dynamic environmental effects in the simulation environment
- An understanding of the effects of the environment upon propagation paths in various wavelengths and their effects upon sensors operating in the spectra of visible, ultra-violet, infrared, radar/ESC/ECM, communications, and aural.
- An ability to use all available means including documentation, source code, and discussions with SME's to analyze existing systems and to identify areas for potential reuse
- A general knowledge of HLA/RTI and the transfer methods used to distribute environmental updates
- A general knowledge of SEDRIS and the provision for storage and retrieval of METOC representation
- Ability to apply current and future technology to METOC representation system design.

D.3.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.3.4. Developmental Path:

- Participate in requirements analysis and system design process for development of the METOC representation to support a simulation system. This will provide a basic foundation and aid in the understanding of performance requirements and design tradeoffs.
- Work closely with and assist a senior systems engineer in the development, integration, and testing of environmental effects models for a simulation system.
- Survey appropriate internet sites to gain a familiarity with available processes and products to support environmental representation.
- Attend conferences related to dynamic environmental effects, and modeling and simulation environmental representation applications. These include the CGF and SIW conferences.
- Monitor industry environmental

D.3.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.3.6. Sustainment to Maintain Expertise:

- Maintain skills in environmental system design by monitoring environmental representation development and Government/Industry R&D efforts.
- Survey appropriate internet sites to maintain familiarity with available processes and products and identify emerging technologies available to support environmental representation.
- Attend conferences related to dynamic environmental effects, and modeling and simulation environmental representation applications.
- Continued support of programs which require environmental representation systems.

D.4. Specific Skill: Behavior Modeling (Intelligent Agent techniques, reactive, cognitve behavior, learning algorithms, etc…)

D.4.1. Description of Skill: The behavioral modeling of entities in the synthetic environment can be classified in three categories: Basic platform behavior. This includes primitive behaviors performed at a single entity level such as move, shoot, and communicate. At a higher level, is the Crew Behavior. This includes all of the behavioral modeling at crew level and includes modeling all the coordination that takes place in a single vehicle at the crew level (i.e. interaction between Tank Commander, Gunner, and Loader technics etc.). At the highest level is the behavior modeling of multiple vehicle interactions (i.e. Platoon, Company, Battalion, etc.). In CCTT SAF, these high level tactics and behaviors are encapsulated in what is known as Combat Instruction Sets (CIS) developed by PM CATT and approved by the appropriate schools.

Behavioral representation at all levels require knowledge of the following: military vehicles and weapons systems, combat doctrines and tactics, sensors, synthetic terrain representation, environmental representation, mobility, terrain reasoning, routing, obstacle avoidance, User's Control Interface (UCI), Command From Simulator (CFS), decomposition of orders especially at the Company and Battalion echelon level as well as an understanding of the interaction of all the above.

Intelligent agent representation of reactive behaviors, cognitive behaviors, and learning algorithms requires knowledge of techniques such as: Finite State Machine (FSM) implementation/usage; Artificial Intelligence (AI); Knowledge of Expert Systems; Neural Nets; Data Driven Systems; C4I Interfaces for CGF; Methods/Technology to control SAF entities/platforms to included extrapolated Robotics technology, and the interaction of all the above automation technologies.

D.4.2. Basic/Minimum Knowledge: Basic knowledge for behavioral modeling includes the understanding of protocols such as the High Level Architecture (HLA), Distributed Interactive Simulation (DIS, DIS ++). Knowledge of Object Oriented Design (OOD), and SAF workstations. Synthetic Environment implications on CGF to include correlated databases with visual/synthetic environment(s). Knowledge and understanding of tactics (i.e. understand battlefield Operating Systems). Knowledge of the SAF User Computer Interface (UCI). Higher level design of exercises that requires delegation and/or decomposition of orders especially at the Company, Battalion echelon level. Basic knowledge of behavior implementation technologies at all levels to include AI, FSM, Data driven systems, and C4I application to CGF.

D.4.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.4.4. Developmental Path: An engineer can developed the above listed skills by attending government or privately operated seminars, courses that typically last one to four days. Active participation in Computer Generated Forces (CGF) Conferences, ModSAF seminars, I/ITSEC, DIS Conferences, HLA, DIS, DIS++ conferences act as vehicles for the development of these skills. Proceedings of the above conferences are an excellent source of knowledge in the behavioral representation area and can be helpful in developing the required skills. Hands on participation in design and testing of SAF/CGF systems can help to quickly develop skills in this area. In addition, Mentoring with senior SAF/CGF system SMEs will close the lose ends left from the above learning techniques. The combination of all identified methods of training/assignments will be the most effective path to develop knowledge and to build experience in the behavioral modeling representation at all levels.

D.4.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.4.6. Sustainment to Maintain Expertise: To maintain an acceptable level of expertise and knowledge in this area, I recommend periodic training and SAF/CGF assignments as described above. In addition, get hands on participation as much as possible in a SAF/CGF project.

D.5. Specific Skill: Computer Generated Force (CGF) Applications

D.5.1. Description of Skill: This skill is the capability of applying CGF as an integral part of a simulation system. These systems could be in any of the three domains including; Training Exercises and Military Operations (TEMO) training systems (including virtual/entity based and constructive), Analysis Concept and Requirements (ACR) and Research Development and Acquisition (RDA).

D.5.2. Basic/Minimum Knowledge: Basic understanding of how TEMP, ACR and RDA use CGF applications. Understand what it can and can't do to have realistic expectations of the technology. Understand the differences in the CGF capabilities as used in different domains and simulations. Suggest basic ModSAF training and/or exposure to ModSAF, ITEMS, CCTT, Janus, CASTFOREM (COMBAT XXI) and other CGF intensive simulations/modeling tools.

- A good perquisite background for all CGF Engineers is Software Engineering, and Simulation Protocols (e.g. HLA), Since CGF makes extensive use of both. Also working and managing teams such as Integrated Development Teams (IDT) is helpful.

- Knowledge of military tactics and equipment is critical to CGF requirement definition and testing. Suggest Army 101 type training and monitoring training operations.

- Synthetic Environment implications on CGF to include Correlated databases with visual/synthetic environments. Suggest classes/presentations on SEDRIS, visual systems, STOW and SAF Collated database design.

- Knowledge of Operator Interface design for the SAF/CGF workstation including new digital C4I systems. Suggest exposure to different CGF systems. Training on Force XXI systems.

- Knowledge of robotic control systems, Finite State Machine (FSM) implementation/usage, obstacle avoidance , routing and other methods used to control CGF entities. Suggest College classes and CGF conference presentations.

D.5.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.5.4. Developmental Path: TBD.

D.5.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.5.6. Sustainment to Maintain Expertise: TBD.

D.6. Specific Skill: Display Systems

D.6.1. Description of Skill: The skill associated with display system analysis, design and testing requires the individual to have a solid understanding of the various display technologies and their associated performance parameters and characteristics. The individual must be able to use this knowledge to analyze display system design related to training requirements and related visual system tradeoffs (with image generation system and database design).

D.6.2. Basic/Minimum Knowledge:

- A solid understanding of the various types of display technologies to include: CRT, LCD, EL, Plasma, etc.
- A solid understanding of display system components to include: large screen projection (flat screen and dome), HMD's, head and eye tracking, rear projection screens, collimated display systems, retinal scanning systems, optical components.
- Ability to analyze training requirements and develop complex system level and component level performance parameters and designs.
- Hands-on experience through testing of actual display systems.
- A solid understanding of the tradeoffs that exist between display system design and the performance of the integrated visual system (display system, image generation system, and database).
- Ability to apply current and future technology to display system design.

D.6.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.6.4. Developmental Path:

- Attending conferences related to display components, display technology, and training and simulation display applications. These include: Image Society Conference, SID Conference, SPIE Symposium, INFOCOMM, I/ITSEC.
- Involvement in the development of a training device visual system specification is an important step in obtaining the knowledge and understanding of performance requirements and design tradeoffs related to display systems.
- Working closely with and assisting a senior visual engineer in the testing of display systems on a training device.
- Monitor industry display product development as well as Government and Industry R&D efforts.

D.6.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.6.6. Sustainment to Maintain Expertise:

- Maintain skills in display system design by monitoring industry display product development and Government/Industry R&D efforts.
- Continued support of programs which require display systems.
- Attending conferences related to display components, display technology, and training and simulation display applications. These include: Image Society Conference, SID Conference, SPIE Symposium, INFOCOMM, I/ITSEC.

D.7. Specific Skill: Embedded Simulation

D.7.1. Description of Skill: Embedded Simulation or Embedded Training is a training methodology/strategy that enhances or maintains skill proficiency by allowing soldiers to train using their operational system. One must be knowledgeable in the types of embedded simulation/training. "Fully" embedded simulation/training is completely resident in the "prime" or operational system. Embedded simulation/training can also be provided using "appended" or "umbilical" systems that are attached or connected to the operational system. One must also fully understand the "resource constrained" environment that embedded simulation/training must operate in. One must have the ability to understand the user requirements and translate those requirements into embedded simulation/training design requirements. One must have the ability to make technical trade-offs and the ability to optimize the operational system's hardware performance for embedded simulation/training capabilities. One must have a good understanding of interfaces and be able to define those interfaces in an Interface Control Document (ICD). One must have a good understanding of digital and analog simulation techniques.

D.7.2. Basic/Minimum Knowledge:

- Knowledge of hardware and software analysis and design techniques
- Knowledge of hardware interface types including digital and analog (RS232, RS170, etc.)
- Knowledge of CPU architectures and their performance capabilities
- Knowledge of real-time operating systems (i.e., Windows NT, Windows CE, Unix, etc.)
- Knowledge advance hardware technologies in 3D graphics, sound, and input devices
- Knowledge of memory types (RAM, ROM, EEPROM, Flash, etc.)
- Knowledge of APIs and embedded libraries (PDF and HTML formats)
- Knowledge of programming languages (C++, EC++, Ada, Visual BASIC, etc.)
- Knowledge of bus/network capabilities
- Knowledge of control processing and image/signal processing
- Knowledge of tutoring and CBT systems including intelligent simulations
- Knowledge and understanding of Instructional Systems Designs (ISD)
- Ability to work closely with the operational system developer in an IPT environment
- Ability to "reuse" simulation components previously developed

D.7.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.7.4. Developmental Path:

- Attend technical courses to keep current with technology advances
- Attend simulation conferences/workshops
- Attend a course in ISD and associated ISD techniques
- Work on an embedded training R&D project like INVEST for experience in requirements
- analysis and concept formulation
- Work on a "development" program that is applying embedded simulation/training techniques

D.7.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.7.6. Sustainment to Maintain Expertise:

- Attend technical course at least once a year
- Rotate work assignments with programs in different acquisition phases.

D.8. Specific Skill: Multi-Resolution Modeling (i.e., Fundamentals, modeling process, etc…)

D.8.1. Description of Skill: Capability to develop conceptual models (that identify and describe key components and interactions and the relationships used to express and relate different levels of resolution in model representations). Capability to conduct requirements analysis to determine the importance and need for multi-resolution models with regard to system performance, interoperability and reuse. Capability to identify and select cost effective methods for achieving multi resolution representation. Capability to analyze and express muti-resolution modeling requirements in proposals. Capability to develop, direct and/or approve test and evaluation plans and/or VVA plans for certifying multi-resolution model representations and relationships. Capability to review and assess software implementation of multi-resolution models

D.8.2. Basic/Minimum Knowledge:

- Methods of knowledge representation/engineering.
- Methods and techniques related to:
  - Data organization, structures, and interchange formats.
  - Object modeling; Universal Modeling Language
  - Conceptual Modeling, Requirements Modeling.
  - Abstraction Description and Relationships
- Contemporary software design practices and approaches
- System architectures
- VVA methods and techniques
- Major types of simulation implementation (HLA, Distributed Simulation, Discrete Event Simulation, etc.)
- Information technology

D.8.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.8.4. Developmental Path:

This will take a little while to work out. Basically, I see this beginning with a description of individual knowledge/skill packages that could do one or more of the parts of a journeyman level description. Then as experience grows along the developmental path, the person would become knowledgeable and proficient in doing more of the individual packages at a more comprehensive level. Positions above journeyman would be leading advances in modeling and representation methods. Formal training required in all the methods identified above (modeling, OO, Methods, VV&A, HLA, M&S in general)

D.8.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.8.6. Sustainment to Maintain Expertise:
Would like to see this as periodic hands-on (participative) training conducted in partnership between IST and STRICOM to provide a common baseline of knowledge and skills while at the same time providing an outlook of emerging trends. This could be a "multi-level resolution" offering with some elements more for the generalists and others for the specialists. Other types of activities include those we do regularly – conferences (DoD and technical), simulation classes, some other university advanced classes.

D.9. Specific Skill: Physical Modeling (object & interaction, movement, sensor, engagement, communication, etc.)

D.9.1. Description of Skill: {Before I get into physical modeling, I need to explain a little about the Warfighters' Simulation (WARSIM) 2000 program.} The WARSIM 2000 training system is a computer-based simulation system with associated hardware to support training of U.S. Army commanders and their staffs from battalion through theater level. Two of the WARSIM's 2000 main software Computer Software Configuration Items (CSCI's) are Unit and Equipment CSCI's. The Unit CSCI's primary responsibility is the simulation of the cognitive effects of Command and Control (C2) of units: situational awareness, decision making and planning. In a sense, Unit CSCI provides a unit's "mind" while Equipment CSCI provides the "body". Therefore, physical modeling in the WARSIM 2000 program falls mainly in the Equipment CSCI, which I will discuss in more detail. The Equipment CSCI interacts with and senses the simulated world at the individual, vehicle, and equipment level and reports actions and events to the Unit CSCI. The Equipment CSCI models the physical aspects of a unit including its equipment, supplies, and personnel. The Equipment CSCI models specific equipment and personnel capabilities (e.g., shoot, move, sense, communicate), damage to equipment and personnel (e.g., munition hit, disease/non-battle injury, stochastic failure), the impact of equipment and personnel on the simulation, the level of available supplies, etc. . The Equipment CSCI executes commands received from the Unit CSCI by utilizing line-of-sight, weather, terrain, and atmospheric data received from other CSCIs.

In summary, WARSIM equipment and personnel platforms are grouped into equipment groups. The platforms and groups are simulated by the Equipment CSCI and provide the physical modeling of units to include their mobility, communications, sensing, weapons/munitions, damage, engineering modifications, logistics. The cognitive portion of the simulated units are modeled by the Unit CSCI.

D.9.2. Basic/Minimum Knowledge:

- Software Engineering Process and knowledge of each phase (Requirements Analysis, Preliminary Design, Detailed Design, Code and Unit Test, System Integration).
- Software Development Methodology types (Spiral/Incremental, Waterfall, etc.).
- Object Oriented Methodology & o-o products (Object Models, State Transition Diagrams, Event Traces).
- Working in a teaming environment: IPTs / Integrated Development Teams (IDT) / Concurrent Engineering Teams (CET).
- Knowledge in these areas: Artificial Intelligence (AI) techniques (Rule-based systems, State-space search, and Case-based reasoning), Finite State Machine (FSM) implementation.
- Knowledge in these areas also: Army 101 type classes, Environment (Terrain, Weather, etc.), C4I, After Action Review (AAR), Surrounding Forces (BLUFOR) / Opposing Forces (OPFOR), Military Operations Other Than War (MOOTW), Commander's Agility (CA), Attrition, etc. .

D.9.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.9.4. Developmental Path:

- Courses/Training/project experience in all the above areas
- Attend an Army Simulation Exercise (i.e., CBS exercise)
- Mentoring from an experienced engineer in a similar area
- Team building / Management training or classes

- Cost/Schedule/Software Metrics training or classes
- Time management / communication training or classes
- MIL-STD-498 (Software Development and Documentation)
- FM 101-5 (Staff Organization and Operations)

D.9.5. Training or Work Assignments Comprising Developmental Path:

- RECOMMENDED CONFERNCES:
  - High Level Architecture (HLA)
  - Software Technology Conference (STC)
  - Computer Generated Forces (CGF)
  - ModSAF seminars
  - Distributed Interactive Simulation (DIS) and DIS++
  - I/ITSEC
- PROJECT ASSIGNMENTS/EXPERIENCE:
  - Warfighters' Simulation (WARSIM) 2000
  - WARSIM Intelligence Module (WIM)
  - Joint Simulation System (JSIMS)
  - Corps Battle Simulation (CBS)
  - Brigade/Battalion Simulation (BBS)
  - Combat Service Support Training Simulation System (CSSTSS)

D.9.6. Sustainment to Maintain Expertise: TBD.

D.10. Specific Skill: Sensor Simulation/Stimulation

D.10.1. Description of Skill: The skill associated with sensor simulation design requires the individual to have a sound understanding of the various types of sensor systems and their operation. These include: night vision goggles (NVG) image intensification devices, forward looking infrared (FLIR), Radar, low light level television (LLLTV), etc. The individual must also be able to analyze training requirements related to the sensor systems and make simulation design decisions and tradeoffs for the integrated system (displays, image generation, and database).

D.10.2. Basic/Minimum Knowledge:

- A solid understanding of the various types of sensor technologies to include: night vision goggles (NVG), forward looking infrared (FLIR), Radar, low light level television (LLLTV), etc.
- A solid understanding of both sensor simulation and stimulation techniques.
- Ability to analyze training requirements and develop complex system level and component level performance parameters for sensor simulation and stimulation system designs.
- Hands-on experience through testing of actual sensor simulation and stimulation systems.
- A solid understanding of the tradeoffs that exist in designing a simulated or stimulated sensor system (display system, light tight environment issues, image generation system, and database design).
- Ability to apply current and future technology to sensor system design.

D.10.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.10.4. Developmental Path:

- Attending conferences related to sensor technology performance, display technology, and training and simulation applications. These include: Image Society Conference, SID Conference, SPIE Symposium, INFOCOMM, I/ITSEC.
- Involvement in the development for a training device sensor system specification is an important step in obtaining the knowledge and understanding of performance requirements and design tradeoffs related to sensors.
- Working closely with and assisting a senior visual engineer in the testing of simulated and stimulated sensor systems on a training device.
- Monitor sensor development as well as Government and Industry R&D efforts.
- Attending Industry and Government sponsored developmental courses related to sensor simulation/stimulation.

D.10.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.10.6. Sustainment to Maintain Expertise:

- Maintain skills in display system design by monitoring industry display product development and Government/Industry R&D efforts.
- Continued support of programs which require display systems.
- Attending conferences related to sensor technology performance, display technology, and training and simulation applications. These include: Image Society Conference, SID Conference, SPIE Symposium, INFOCOMM, I/ITSEC.

D.11. Specific Skill: Synthetic Natural Environment (SNE) Representation and Interchange

D.11.1. Description of Skill: The skill associated with Synthetic Natural Environment (SNE) Representation and Interchange requires the individual to have a solid understanding of SNE database formats and modeling requirements. The individual must understand SNE interchange issues and the effects of SNE databases on interoperability.

D.11.2. Basic/Minimum Knowledge:

- A solid understanding of the various SNE data source formats including terrain, cultural features, imagery, atmospheric and ocean data.
- A solid understanding of various SNE database generation system and real-time formats, and algorithms and models which use SNE data.
- Ability to analyze SNE requirements and implications for SNE data models and formats.
- A solid understanding of SNE interchange issues.
- Hands-on experience with database generation software and SNE interchange software and tools.
- A solid understanding of the tradeoffs that exist between database content, format, interchange mechanisms and interoperability within networked simulations.
- Ability to apply current and future technology to SNE database modeling and interchange.

D.11.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.11.4. Developmental Path:

- Attend SEDRIS briefings, view and understand SEDRIS videotapes, read and understand SEDRIS documentation.
- Familiarization with database generation software available in lab.
- Courses on source data available at Defense Mapping School, courses on terrain database generation from various vendors.
- Attend conferences related to SNE and interoperability. These include: SISO conferences, DMSO symposiums.
- Monitor industry SNE data source and modeling developments as well as Government and Industry R&D efforts.

D.11.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.11.6. Sustainment to Maintain Expertise:

- Maintain skills in SNE by monitoring industry database development and Government/Industry R&D efforts.
- Continued support of programs that require SNE data, data interchange, and SNE interoperability within networked systems.

D.12. Specific Skill: Terrain Database Modeling & Representation

D.12.1. Description of Skill: The skill associated with Terrain Database Modeling and Representation requires the individual to have a solid understanding of terrain database source data and formats. The individual must understand terrain database generation systems, formats and modeling requirements, and a basic understanding of image generators and display systems. The individual must be able to use this knowledge to perform tradeoffs between user requirements and database content, based on image generator and display system limitations. The individual must understand SNE interchange issues and the effects of SNE databases on interoperability.

D.12.2. Basic/Minimum Knowledge:

- A solid understanding of the various terrain data source formats including terrain elevation data, cultural feature data, three-dimensional models and imagery; and various terrain database generation systems and image generator real-time formats.
- A solid understanding of image generators and display systems, their relationship to the terrain database and the limitations they place on the database content, format, size, etc.
- Ability to analyze terrain database requirements and perform tradeoffs based on image gnerator and display system characteristics.
- A solid understanding of terrain database interchange issues and formats.
- Hands-on experience with database generation software and interchange software and tools.
- A solid understanding of the tradeoffs that exist between database content, format, interchange mechanisms and interoperability within networked simulations.
- Ability to apply current and future technology to terrain database modeling.

D.12.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.12.4. Developmental Path:

- Familiarization with database generation software available in lab.
- Courses on source data available at Defense Mapping School, courses on terrain database generation from various vendors.
- Attend SEDRIS briefings, view videotapes and understand documentation.
- Attend conferences related to terrain databases. These include: NIMA and TEC symposiums, the IMAGE Society Conference, SISO conferences, DMSO symposiums, I/ITSEC, vendor briefings on terrain database generation systems, image generators and displays.
- Monitor industry terrain data source and modeling developments as well as Government and Industry R&D efforts.

D.12.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.12.6. Sustainment to Maintain Expertise:

- Maintain skills in terrain by monitoring industry database development and Government/Industry R&D efforts.
- Maintain skills in terrain database generation systems and formats.
- Continued support of programs that require terrain databases.

D.13. Specific Skill: Visual Engineer

D.13.1. Description of Skill: Performs engineering analysis, preliminary design and testing of sensor and visual simulation systems employing Computer Image Generation Technology, Digital Database technology, and Visual Display Technology.

- Perform preliminary engineering analysis to define visual system requirements to meet the stated training task.
- Prepare engineering specifications for Visual System in response to training requirements. A detailed or functional specification is developed after considering many factors which differ with each training application (i.e., competition considerations, prior Government and/or contractor experience, unique user requirements, etc.).
- Define preliminary design including design trade-offs to provide the optimum balance of performance and cost.
- Insure the application of sound principles of human factors to visual system design.
- Evaluate contractor's proposed designs relative to their technical risk and ability to meet the stated performance requirements.
- Evaluate contractor detail designs for compliance with contract technical requirements.
- Evaluate contractor test plans and detailed test procedures to determine that tests adequately verify performance to specification requirements.
- Advise project, lead, user and team engineers concerning design alternatives and user acceptability.
- Define sensor and visual scene content requirements and advise government team on alternatives to achieve adequate visual cues in the digital database.
- Test and evaluate the system to establish compliance with contract technical requirements.
- Determine remedial actions required to achieve training levels of performance.
- Provide consultation and engineering analysis services to support Government planning for future simulation systems.
- Recommend procedures and design methods to insure successful integration of the complete simulation system. Perform engineering analysis of relationships between visual system, and motion simulation, correlation between Computer Generated Forces, Support stations, Network Protocol (IOS, Communications, After Action Review, etc.) for all elements of the system affecting integration of the system.
- Participate and oversee BAA and SBIR programs which advance visual systems technology.
- Keep abreast of visual systems technology. Involvement in SEDRIS and HLA activities.
- Provide consultation in the areas of synthetic environment interoperability.

D.13.2. Basic/Minimum Knowledge: Database development and interrelationship with the Image Generation System. Understanding of the performance parameters and trade-off (i.e. scene content, update rates, etc.). Interrelationship between the Image Generation System and Display System and the performance parameter trade-offs. Understanding the performance parameters (resolution, color conversion, luminance, etc.) of the Display System. The ability to Test and measure visual system parameters. Ability to operate test equipment to measure parameters. Knowledge of DIS/HLA and CGF for interoperability with the Visual System. Understanding of Motion Systems, Sensors and Host Software which interact and communicate with the Visual System. Some understanding of existing and future hardware/software technologies. Understanding of NIMA digital products (DTED, DFAD, ITD, VPF etc.). Understanding of interchange formats for the Synthetic Environment such as SEDRIS, OPENFLIGHT, SIF, etc.

D.13.3. Training or Work Assignments Contributing to Basic Knowledge: Mentoring with senior visual engineer. Involvement in visual/systems testing. Attend Conferences such as I/ITSEC, IMAGE, SID and SPIE. Special contractor seminars for visual systems (E&S University, SGI technical briefings, etc.) Attend HLA and CGF conferences. Graduate Courses in Computer Engineering and Simulation&Technology track of Industrial Engineering.

D.13.4. Developmental Path: TBD.

D.13.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.13.6. Sustainment to Maintain Expertise: TBD.

D.14. Specific Skill: Visual System Design

D.14.1. Description of Skill: TBD.

D.14.2. Basic/Minimum Knowledge: TBD.

D.14.3. Training or Work Assignments Contributing to Basic Knowledge: TBD.

D.14.4. Developmental Path: TBD.

D.14.5. Training or Work Assignments Comprising Developmental Path: TBD.

D.14.6. Sustainment to Maintain Expertise: TBD.

Appendix E
Principal Investigator Specific Skills

E.1. Description of Skill:
The PI needs to be as Dr. F. L. Fernandez, the Director of DARPA, says, “A green eyed zealot!” In addition the PI’s skill base consists of all the skills listed for the other three functional bands.

The PI’s have 3 parts to their mission listed in priority order:
1. Technological excellence in their domain.
2. Transition of technologies.
3. Program Management.

The Principal Investigator’s primary focus is technology development. To achieve this requires that each PI be a Subject Matter Expert (SME) in their designated area of expertise. A PI need’s to be technically excellent, pragmatic, entrepreneurial and a project manager to ensure the success of their project. PI’s have the opportunity/responsibility to define the future of STRICOM. This is achieved by creating the cutting edge technology that will make it possible. Unlike the rest of the engineering directorate PI’s are provided with funds to implement their technologies. PI’s, since they have control of their funds are empowered systems engineers. In general knowledge of a wide range of the skills listed for the other bands is beneficial. A PI must be an advocate for their technology. To effect transition would require PI’s to have a mindset where the future of the technology would be considered up front. This could include transition offsites, mentoring of engineers that support us and the establishment of regular lines of communications with the PM's that could include their participation in IPT's, MOA's and their buy in to the given technology that we are developing. For transition to work all sides must have something to gain. It must be a win-win situation for all parties. A PI is responsible for the judicious allocation of their funds. Leveraging to increase the effect of these funds is a primary goal. Standard program management functions must be addressed: Timely award of contracts, early obligation of funds and ensuring of their proper disbursement.

E.1.2. Basic/Minimum Knowledge:
- Be a leader.
- Recognized as an expert in their domain
- Act as an entrepreneur. The ability to start new technology development by gaining funds for their implementation.
- Knowledge of technology development
- Ability to initiate/prepare/finalize TPA’s and MOU’s
- Knowledge of R&EM Analysis Techniques and system engineering processes.
- Knowledge of the IPT process and ability to work as a team member.
- Knowledge of contractual aspects of R&EM within DoD programs.
- Be able to Establish of networking relationship with Government and Industry having interest in the Command R&EM program.
- Broad knowledge of Federal/State/local policy, regulations and practices related with the Army R&EM program.
- Have obtained formal training and education on RE&M related fields.
- Ability to analyze complex technical engineering related problems, to develop effective solutions, and to manage the assigned work along with being a contributing member of a multi-disciplined technical team.
- Ability to communicate effectively, both orally and in writing. This includes STRICOM internal and external organizations

E.1.3. Training or Work Assignments Contributing to Basic Knowledge:
A Graduate degree in Engineering, Mathematics, Physics, Computer Science, related technical degree, or Graduate Business degree.
Rotational assignment to DARPA, ES, ET, ARI, ARL that involves technology development.

LEADS

E.1.4. Developmental Path:

- Level 1 Intern
- Level 2 Practitioner
- Level 3 Lead
- Level 4 Senior Lead

E.1.5. Training or Work Assignments Comprising Developmental Path:

Level1 Intern:

- DAU SYS 301 (Summary of Systems Engineering Principles with Integrated Product Team (IPT) applications), or Level III Certification in SPRDE.
- Rotational assignment in technology development

Level 2 Practitioner:

- Technology development lead for a given project.
- Rational Software's *Requirements Management With Use Cases* course, or equivalent. (State of the art course on Systems Requirements Management/Functional Analysis)
- UCF's EIN 6140 *Project Engineering* Course (Technical Project management with an emphasis on building systems), or ESI 6551c *Systems Engineering* Course.
- UCF's EIN 6645 *Modeling and Simulation of Real-Time Processes* course or equivalent. (Excellent course in Object Oriented Technologies (OOT) and their application to M&S)
- LEADS , or PME I, or OLE, (Leadership development)

Level 3 Lead:

- A Graduate degree in Engineering, Mathematics, Physics, Computer Science, or related technical degree.
    - OR A Masters in Business Administration (MBA)
    - OR Complete Defense Systems Management College Advanced Program Management Course (APMC) - PMT 301
    - OR Attain Dual DAWIA Level 3 Certification in both SPRDE and Acquisition
- AND
- A minimum of three years experience in a technology development area.
- Successful development of technology area with funding, or technology development area SME, or Science and Technology Objective (STO) Manager.
- Recognized as a SME in their domain

Level 4 Senior Lead:

- A PhD in Engineering, Mathematics, Physics, Computer Science, Business, related technical or business degree.
- OR
    - Experience as a DARPA PM, or other equivalent high-level technology experience.
- AND

    A minimum of five years experience in a technology development area, or Science and Technology Objective (STO) Manager.

E.1.6. Sustainment to Maintain Expertise: 80 hours per year of technical training.