Development and Validation of a Systems Engineering Competency Model

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Overview

- Why Competency Management?
- Senior Leadership Support
- Competency Management Process
- Proposed Next Steps
- Summary
Why Competency Management for AT&L and Systems Engineering?

Competencies are observable, measurable patterns of knowledge, skills, abilities, behaviors and other characteristics that an individual needs to perform work roles or occupational functions successfully.

Competency management helps:
- **Assess** and **refine** the requisite competencies within the current workforce
- Develop appropriate **strategies** to shape the skill sets and capabilities needed by the **future workforce**
- Identify overall **capabilities** we need to execute the **acquisition mission**
- Evaluate which competencies are **mission critical** and **highest priority**
- Develop solutions that will help us **mitigate risk** and **respond** to the challenges
**Competency Model Applications**

**Agile Mission Support**
- Enables tactical, agile targeting of resources to achieve desired capability
- Enables improved organizational refinements to align the skills with mission needs

**Improved Learning/Training**
- Improved alignment of training to “successful performance” needs
- Improved training investment
- Enables 21st Century Training Framework (Core Plus)

**Succession Planning**
- Identify expected critical vacancies
- Identify employees & candidate gaps

**High(er)-Performing Workforce**
- Improved engagement of workforce to “successful performance” support resources (that make a difference)
- Better migration of Best Practices

**Improved Gap Assessment ROI**
- Assess proficiency AND
- Assess Mission Criticality, Frequency, and Difficulty
- Migrate best practices & tools for successful performance

**Strategic Workforce Planning**
- Strategic planning enabler for leaders
- Enhanced Management of Mission Critical Competencies
- Deliberate, earlier “change management”
- Information for tactical resource decisions

**Recruiting & Selection**
- Improve identification of key behaviors contributing to successful performance
- Improve the “Benefits Package” story – “World-class tools for your development and success”

**Development & Career Planning**
- Enhance Individual Development
- Enhance Organization Development

**Human Resources System**
- Learning Management System

**Performance Management System**
- Learning Content System

**Competency Models**
Senior Leadership Support is Critical!!!

Align with Senior Leadership

DoD Alignment
“The department must have a vision that conveys to the public a commitment to attract & develop the best mix of people, both military & civilian. This vision must be supported by an effective human capital strategy that is actively measured against well defined goals.”

Robert Gates - SECDEF
Gordon England - DEPSECDEF

National Security Strategy
National Defense Strategy
National Military Strategy
Quadrennial Defense Review
DoD Civilian Human Capital Strategic Plan

AT&L Competency Management Initiative ... Enabling Successful Acquisition Outcomes
**AT&L Competency Management Process**

**Collect Existing Competency Data**

**Framework Development**

**Model Development**

**Model Testing & Refinement**

**Competency Validation, Assessment, and Sustainment**

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**Phase I - Convene an expert panel (EP)**

**Actions:**
- Develop a competency framework & input model
- EP identifies Subject Matter Experts (SMEs)
- EP communicates competency effort to the SMEs
- Develop communications package

**Goal:**
- Establish baseline of existing competency model.
- Communicate effort

**Products:**
- FA provides list of targeted high-performing SMEs
- Obtains expert panel concurrence on baseline competency framework
- Obtain approval from Dir, HCI and FA on competency model input

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**Phase II – Develop the model**

**Actions:**
- SMEs review the competency framework and provide essential job data through structured interviews and online data collection tools.
- SMEs engaged to identify key “work” situations and competencies contributing to successful performance
- Analyze results and develop competency model content

**Goal:**
- Model development and identification of key behaviors

**Products:**
- Deliver Proposed Model Report to Dir, HCI and FA for review

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**Phase III – Perform a beta test & refine model**

**Actions:**
- Collect and synthesize feedback from proposed model report
- Pre-assessment communications to workforce
- Identify stratified workforce sample

**Goal:**
- Further refine model to include input from functional leads
- Obtain FA and Dir, HCl approval for validation assessment

**Products:**
- Deliver Proposed Model Report to HCl, FA and Dir for review
- Obtain approval from Dir, HCl and FA on competency model

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**Phase IV – Validate and assess**

**Actions:**
- Launch competency assessment tool
- Analyze results to evaluate model validity and generalizability to the workforce

**Goal:**
- Identify competencies required for superior performance
- Evaluate proficiency gaps for validated competencies
- Plan for continual updates and use of competency model

**Products:**
- Deliver proven (validated) competency model in HR XML format
- Provide competency validation and assessment and obtain Dir, HCl and FA approval

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**Approved Input Competency Model**

**Proposed Competency Model Report**

**Approved Initial Competency Model V 0.5**

**V 1.0 Competency Model**

**Competency Validation & Assessment Report**

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*Slide 6*
Phase I: Expert Panel and Competency Model Framework Development

AT&L Systems Engineering Learning Outcomes (199)

Professional Competencies

Competency Model Framework (40 Technical 10 Professional)
Unit of Competence
Riding a Bicycle

Competency 1
Mount the Bicycle
Element 1 – Position the Peddle
Element 2 – Swing leg/Take seat
Element 3 – Transition to Motion

Competency 2
Dismount the Bicycle
Element 1 – Slow Down
Element 2 – Support at Stop
Element 3 – Swing Leg to Ground

Competency 3
Pedal the Bicycle
Element 1 – Maintain Balance
Element 2 – Peddle Fast
Element 3 – Peddle Slow

Competency 4
Maintain the Bicycle
Element 1 – Tire Pressure
Element 2 – Brake Operation
Element 3 – Wheel Balance
## SE Competency Model Framework

### Technical Competencies

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>7. Modeling and Simulation</td>
<td>27. Technical Data Management</td>
<td></td>
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<tr>
<td>10. Safety Analysis</td>
<td>30. Specifications</td>
<td></td>
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<tr>
<td>11. SE Design Considerations</td>
<td>31. Earned Value Management</td>
<td></td>
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<tr>
<td>12. Requirements Development</td>
<td>32. IMP/IMS</td>
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<tr>
<td>13. Logical Analysis</td>
<td>33. Technical Reviews</td>
<td></td>
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<tr>
<td>14. Design Solution</td>
<td>34. Software Engineering</td>
<td></td>
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<tr>
<td>15. Implementation</td>
<td>35. Systems Engineering by Phases</td>
<td></td>
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<tr>
<td>16. Integration</td>
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<td>17. Verification</td>
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<td>18. Validation</td>
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<td>19. Transition</td>
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<td>20. System Assurance</td>
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### Professional Competencies

<p>| 41. Communication                                   | 42. Analytical Skills                                |
| 43. Decision Making                                 | 44. Problem Solving                                  |
| 45. Technology Management                           | 46. Team Building                                    |
| 47. Influencing and Negotiating                     | 48. Interpersonal Skills                             |
| 49. Strategic Thinking                              | 50. Understanding Attributes of Evidence and Rational Decisions |</p>
<table>
<thead>
<tr>
<th>Unit of Competence</th>
<th>Competency</th>
<th>Elements</th>
<th>Knowledge Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Analytical</td>
<td>Technical Basis for Cost</td>
<td>Apply knowledge of cost drivers to develop cost estimates and program budgets that reflect program phase requirements and best practices.</td>
<td>Knowledge of cost drivers and cost estimating techniques and best practices.</td>
</tr>
<tr>
<td>#1 Analytical</td>
<td>Systems Engineering Plans</td>
<td>Identify the proper points within a program's lifecycle to generate a Systems Engineering Plan (SEP) that describes the program's SE processes, resources, metrics, and technical review process.</td>
<td>Knowledge of SEP preparation guidance</td>
</tr>
<tr>
<td>#1 Analytical</td>
<td>Requirements Development</td>
<td>Apply the Requirements Development process to translate inputs from relevant stakeholders into technical requirements.</td>
<td>Knowledge of requirements management tools</td>
</tr>
<tr>
<td>#1 Analytical</td>
<td>Verification</td>
<td>Apply the Verification process to confirm that the system element meets the design specifications as defined in the functional, allocated, and product baselines and to answer the question 'Did you build it right?'</td>
<td>Knowledge of verification (test and evaluation) techniques</td>
</tr>
<tr>
<td>#1 Analytical</td>
<td>Validation</td>
<td>Apply the Validation process to test the performance of systems within their intended operational environment and to answer the question 'Did you build the right thing?'</td>
<td>Knowledge of validation (operational test and evaluation) techniques</td>
</tr>
</tbody>
</table>
Phase II: Subject Matter Expert (SME) Validation

- SMEs review the competency model framework and provide essential job data through an online data collection tool.

- SMEs can add/delete competencies and associated elements and knowledge items.

- SMEs must identify at least two key “work” situations and associated competencies that contribute to successful performance.

- Results are analyzed and used to develop a complete competency model.
SME Competency Review

SMEs review each competency element and provide information on:

- Frequency
- Importance
- Level First Used

<table>
<thead>
<tr>
<th>Unit of Competence #1 Analytical</th>
</tr>
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<tbody>
<tr>
<td>Includes the analytical and technical processes of systems engineering with a full understanding of tools and techniques and all design considerations.</td>
</tr>
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<table>
<thead>
<tr>
<th>Competency Element</th>
<th>Frequency</th>
<th>Importance</th>
<th>Level First Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Basis for Cost - Element 1: Apply knowledge of cost drivers to develop cost estimates and program budgets that reflect program phase requirements and best practices.</td>
<td>1 Never, 2 Sometimes, 3 Often, 4 Frequently, 5 Very Frequently, N/A</td>
<td>1 Not Important, 2 Less Important, 3 Moderately Important, 4 Important, 5 Very Important, N/A</td>
<td>1 Entry Level, 2 Mid-Level, 3 Expert/Senior Level, 4 N/A</td>
</tr>
<tr>
<td>Systems Engineering Plans - Element 1 of 3: Element 2: Identify the proper points within a program's lifecycle to generate a Systems Engineering Plan (SEP) that describes the program's SE processes, resources, metrics, and technical review process.</td>
<td>1 Never, 2 Sometimes, 3 Often, 4 Frequently, 5 Very Frequently, N/A</td>
<td>1 Not Important, 2 Less Important, 3 Moderately Important, 4 Important, 5 Very Important, N/A</td>
<td>1 Entry Level, 2 Mid-Level, 3 Expert/Senior Level, 4 N/A</td>
</tr>
<tr>
<td>Systems Engineering Plans - Element 2 of 3: Element 3: Develop the critical contents of a SEP including government and contractor SE processes, the technical baseline approach, program control tools, and the role of SE to guide all technical aspects of an acquisition program.</td>
<td>1 Never, 2 Sometimes, 3 Often, 4 Frequently, 5 Very Frequently, N/A</td>
<td>1 Not Important, 2 Less Important, 3 Moderately Important, 4 Important, 5 Very Important, N/A</td>
<td>1 Entry Level, 2 Mid-Level, 3 Expert/Senior Level, 4 N/A</td>
</tr>
<tr>
<td>Systems Engineering Plans - Element 3 of 3: Element 4: Determine what enterprise, system and software architectures are needed to reason about the system, to inform recommendations and decisions regarding software implementations in the context of the system being acquired and to allow effective communication across the stakeholders throughout the system lifecycle.</td>
<td>1 Never, 2 Sometimes, 3 Often, 4 Frequently, 5 Very Frequently, N/A</td>
<td>1 Not Important, 2 Less Important, 3 Moderately Important, 4 Important, 5 Very Important, N/A</td>
<td>1 Entry Level, 2 Mid-Level, 3 Expert/Senior Level, 4 N/A</td>
</tr>
<tr>
<td>Work Breakdown Structure - Element 5: Translate the system design (including all products and services) into a Work Breakdown Structure (WBS) to ensure that all of the appropriate SE activities are implemented.</td>
<td>1 Never, 2 Sometimes, 3 Often, 4 Frequently, 5 Very Frequently, N/A</td>
<td>1 Not Important, 2 Less Important, 3 Moderately Important, 4 Important, 5 Very Important, N/A</td>
<td>1 Entry Level, 2 Mid-Level, 3 Expert/Senior Level, 4 N/A</td>
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Key Situations: a method of data collection from subject matter experts regarding “what it takes” to perform effectively on your job.

Using the STARR Method of Description
1. Do you identify yourself to others as a systems engineer?
2. Do you have the appropriate resources to do your job?
3. Are you allowed to apply new skills acquired through recent education and training to perform your job?
4. Does your organizational culture encourage the application of new skills?
5. Do you believe additional advanced or senior level training in systems engineering is needed?
6. Have you received training associated with integrating software into warfare related systems?
7. If you answered yes to Question 6, has this training provided you with an adequate understanding of potential issues associated with integrating software into warfare related systems?
8. What do you see as the primary community wide SPRDE workforce capability challenge?
Phase III: Test and Refine the Model

- Collect and synthesize feedback, refine the model.
- Further refine model to include input from Expert Panel and functional leads.
- Send pre-assessment communications to workforce.
- Identify stratified workforce sample.
Phase IV: Workforce Assessment

• Launch competency assessment tool.

• Analyze results to evaluate model validity and general applicability to the workforce.

• Identify competencies required for superior performance.

• Evaluate proficiency gaps for validated competencies.

• Plan for continual updates and use of competency model.
Proposed Next Steps

Improve the Competency Model:
• Compare and contrast with other competency models – leverage best of the best
• Incorporate results from SE education and research efforts
• Develop a sub-set of “Core SE Competencies” that define the true Systems Engineers

Apply the Competency Model:
• Use the Core Competency sub-set to help identify the true SEs in the SPRDE career field
• Use the model to develop criteria for hiring Entry-level, Journeyman-level, and Highly Qualified Experts
• Use the model to drive SE education, training, and experience opportunities – a guide to where you should apply resources
Summary

To successfully develop and implement a competency management program, you should:

1. Develop a competency management plan.
2. Solicit and obtain senior leadership support.
3. Develop a competency assessment model framework.
4. Validate the model with high-performing subject matter experts.
5. Test and refine the model with input from the functional leaders.
6. Assess the target workforce against the competency model to identify competencies required for superior performance and to evaluate proficiency gaps.
7. Update the plan and apply the competency model as needed.
8. Provide reports.
Questions?

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Backup Slides
INCOSE UK Advisory Board
Systems Engineering Competencies Framework

Systems Thinking
- Systems concepts
- Super-system capability issues
- Enterprise and technology environment

Holistic Lifecycle view
- Determine and manage stakeholder requirements
- System Design:
  - Architectural design
  - Concept generation
  - Design for ...
  - Functional analysis
  - Interface Management
  - Maintaining Design Integrity
  - Modeling and Simulation
  - Select Preferred Solution
  - System Robustness
  - Integration & Verification
  - Validation
  - Transition to Operation

Systems Engineering Management
- Concurrent engineering
- Enterprise Integration
- Integration of specialisms
- Lifecycle process definition
- Planning, monitoring and controlling
Figure 1-1 System Life Cycle Processes Overview per ISO/IEC 15288