Development of a Systems Engineering Career Competency Model for the U.S. Department of Defense

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Overview

- Introduction to competency modeling and approach
- Systems Engineering Career Competency Model (SECCM)
- Exploring learning domains in Systems Engineering using Bloom's Taxonomy
    - Cognitive and Affective learning domains
- Implications of research
- Summary

What is a Competency?

An observable, measurable pattern of skills, knowledge, abilities, behaviors and other characteristics that an individual needs to perform work roles or occupational functions *successfully* (OPM).
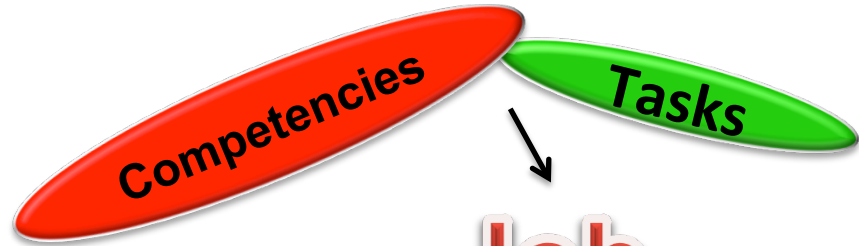
SECCM - Purpose

- The SECCM was developed to document the competencies, knowledge, skills, and abilities (KSAs) that are needed for U.S. defense systems engineers. The SECCM identifies KSAs throughout a systems engineer's career and **identifies an aggregate of KSAs needed for an effective SE workforce.**

- The SECCM competencies are **categorized based on the U.S. Office of the Secretary of Defense Systems (OSD) Engineering (ENG) Competency Model**

- The SECCM is **being used as the basis to create a verified set of defense systems engineering competencies in accordance with (IAW) the Uniform Guidelines** on Employee Selection Procedures

- For the US Government only a **competency model** that is verified IAW the Uniform Guidelines can be **used with confidence** for **"high stakes" human resource functions**

- "High stakes" HR functions are used for **hiring, selection, writing position descriptions, creating job announcements**, etc.

Developing the SECCM using an Excel spreadsheet

- **What's Inside**
  - SE competencies mapped to associated KSAs
  - KSAs partitioned into experience levels
  - Each KSA is categorized using Bloom's Taxonomy (useful for looking at the KSA as a learning objective)

- **Purpose of using an Excel Model**
  - Identify the competencies and perform characterization and categorization "What Ifs"
  - Easier for each organization to tailor the model in a spreadsheet, rather than in a document format, because it provides a real-time capability to edit entries
  - Helps manage configuration control during iterations

Systems Engineering Career Competency Model

**41 Competencies
3,272 KSAs**

Post Review of SECCM:
3,365 KSAs and
44 *verified*
Competencies

- **What's Inside**
  - SE competencies mapped to associated KSAs
  - KSAs partitioned into 3 notional experience levels, designated as *Entry Level, Journey Level* or *Expert Level*.
  - Each KSA is categorized using Bloom's Taxonomy (useful for looking at the KSA as a learning objective)

- **Purpose of using an Excel Model**
  - Identify the competencies and perform characterization and categorization "What Ifs"
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Verified SECCM Competencies

| SYSTEMS ENGINEERING CAREER COMPETENCY MODEL			
Technical Management	**Business Acumen**	**Analytical**	**Professional**
Acquisition	Industry Awareness	Transition	Communication
Risk Management	Organization	Integration	Leading High Performance Teams
Requirements Management	Cost Estimating	Design Considerations	Personal Effectiveness/Peer Interaction
Configuration Management	Proposal Process	Tools and Techniques	Problem Solving
Technical Assessment	Supplier Management	Stakeholders Requirements Definition	Professional Ethics
Data Management	Negotiations	Validation	Strategic Thinking
Software Engineering Management	Requirements Analysis	Verification	Coaching & Mentoring
Decision Analysis	Cost, Pricing and Rates/Cost Management	Mission-Level Assessment	Managing Stakeholders
Interface Management	Financial Reporting and Metrics	Architecture Design	Mission and Results Focus
Technical Planning	Business Strategy	Implementation	Sound Judgment
	Industry Motivation, Incentives, Rewards	Engineering Disciplines	Continual Learning
	Contract Negotiations		

# Bloom's Taxonomy Approach

Psychomotor

Affective
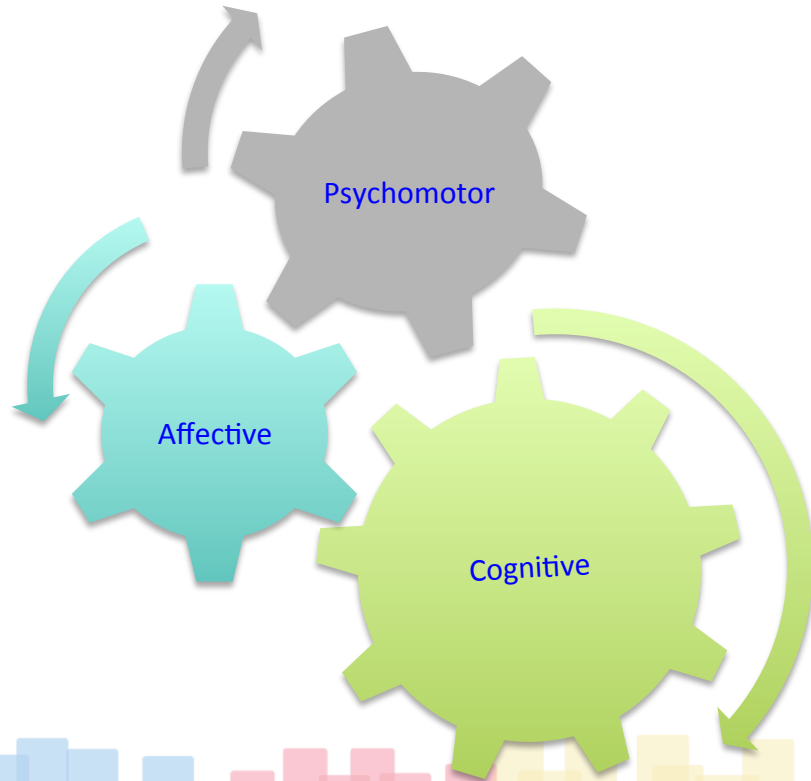
Cognitive

- The SECCM defines KSAs using Bloom's taxonomic classification schema for Cognitive and Affective learning domains.

- Bloom's taxonomic classification schema provides hierarchical categories.
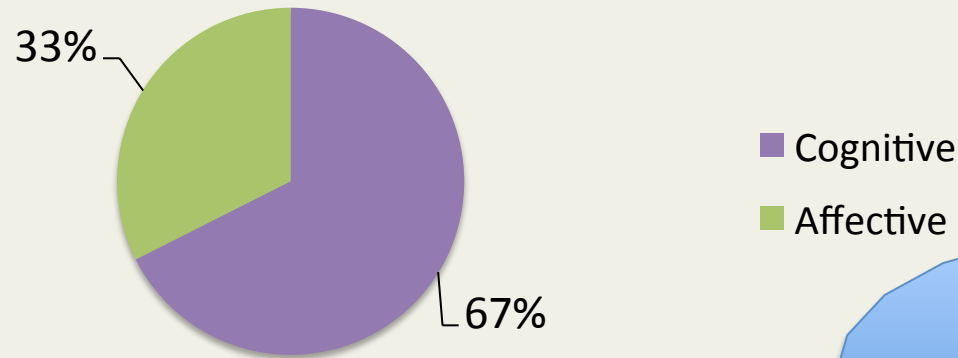
Bloom's Taxonomy Approach: Cognitive Domain
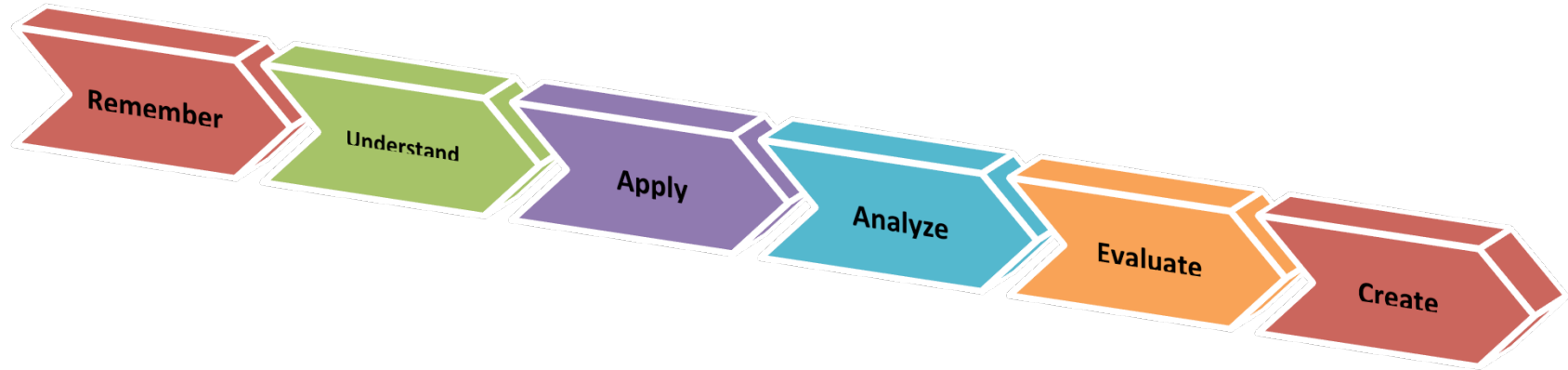
Bloom's Taxonomy Approach: Affective Domain

| Receive | Respond | Value | Organize | Characterize |
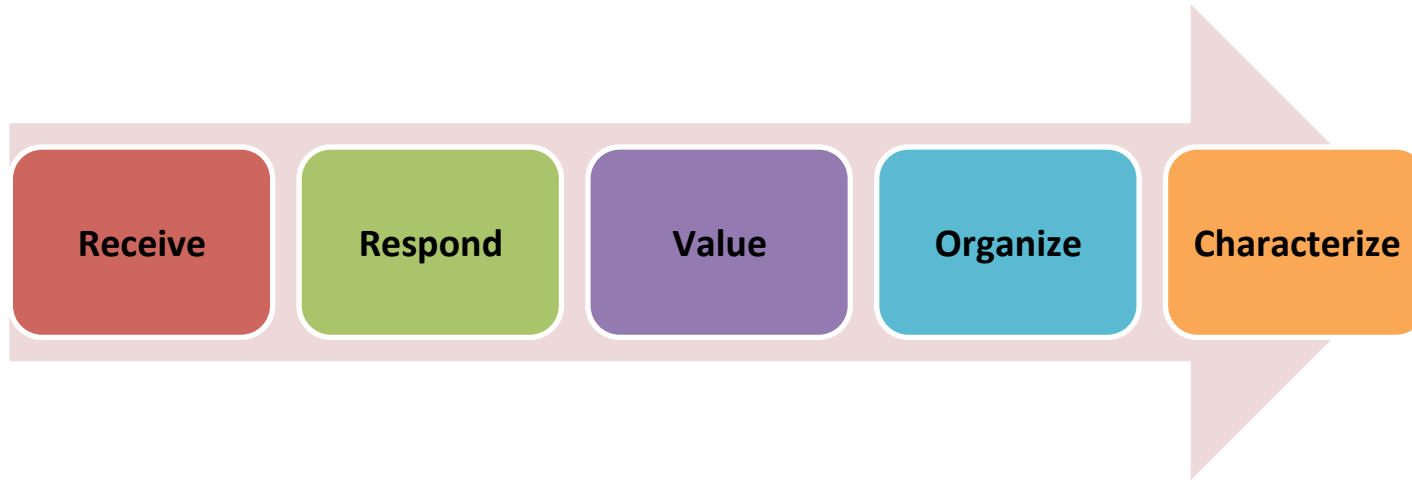
Exploring both Domains in Systems Engineering

Percent of Cognitive and Affective KSAs within the SECCM

33%

67%

- Cognitive
- Affective

Post Review of SECCM:
21%-Affective
79%-Cognitive
(3,272 KSAs)

The engineering profession is highly analytical, requiring both technical and technical management quantitative skills.

Bloom's Taxonomy Approach: Sample of Affective KSAs Required at Entry Level

24.0 PROFESSIONAL ETHICS
Act concisely in a manner that conveys organizational, social, and moral values of the highest standard
Adhere to ethics in conduct
Demonstrate ethical practices accepting responsibility for actions and admitting mistakes
Demonstrate ethical practices by always tell the truth, whether delivering good news or bad
25.0 LEADING HIGH-PERFORMANCE TEAMS
Acknowledge what is unknown and seek greater understanding from appropriate sources inside organization
Demonstrate accountability for the work of individuals who one supervises or leads in a team environment
Maintain appropriate quality oversight for work of individuals who one supervises or leads in a team environment
Establish criteria and/or work procedures to achieve a high level of quality, productivity, or service
Establish stretch goals for self and others that are designed to achieve positive results
Evaluate opportunities systemically and focus work programs on those opportunities with the greatest potential for increasing the organization's value for sponsors, customers, and the public interest
Follow up
Question requests or requirements that can be shown to be unrealistic based on independent evidence
26.0 COMMUNICATION
Adapt communication methods and style based on the players involved and the target objectives
Communicate complex ideas, problems, and solutions in ways that are easily understood (e.g., using examples, visualizations, analogies, animations, discovery maps, interactive displays, and prototype demonstrations)
Understand the material and use congruent non-verbal communication
30.0 PERSONAL EFFECTIVENESS/PEER INTERACTION
Use an open-ended questioning style to explore and clarify information
Adjust behavior to respect observed differences in others
Listen to and fully involve others in team decisions and actions
Listen actively

OPM Methodology for Verification of the SECCM

OPM has been conducting U.S. government wide occupational studies using its Multipurpose Occupational Systems Analysis Inventory-Close-Ended (MOSAIC) methodology.

- MOSAIC is a multipurpose, survey-based occupational analysis approach used to collect information from employees and supervisors on many occupations for a wide range of human resource management functions (OPM 2015).
- OPM drafts a competency model and task list by analyzing the MOSAIC data, reviewing organizational information such as position descriptions, occupational analysis, manpower and other occupational related studies, and reviewing past competency modeling studies conducted by OPM for other agencies.
- Employee and Supervisor subject matter expert panels are conducted and the results of the panels are used to create an "Occupational Analysis Survey".
- The survey respondents are asked to rate the tasks and competencies on frequency, importance, and required at entry.
- The respondents are also asked to respond to a series of questions to self-identify as individuals who perform or supervise personnel who perform the specified type of work.
- **OPM will analyze the data collected in the survey and use this information to identify critical competencies and tasks for DOD Systems Engineers.**

Summary and Implications of Research

- The SECCM is a valuable resource as a model that can be used for key HR functions:
  - **hiring, selection, writing position descriptions, creating job announcements**, etc.

- **Other Possible uses: SE education & training**

  - Assist organizations in designing SE career development plans, and provide undergraduate and graduate SE programs a baseline that identifies the KSAs employers expect system engineers to have obtained from their education

  - The SECCM can also be used to assist undergraduate and graduate academic programs in specifying student outcomes and learning objectives within systems engineering programs.

  - This can help ensure students have the entry-level KSAs required to perform successfully once in the field. The SECCM can then be used as the foundation for competency-based education.

Questions?

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