

Innovative Strategies for Effective System Engineering Training

THE VALUE OF PERFORMANCE.

NORTHROP GRUMMAN

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- The need for trained systems engineers is steadily increasing
- Wide variations exist in the style and content of systems engineering training
- This presentation will highlight these differences, and offer innovative strategies for ensuring systems engineering training is effective
 - Target audience
 - Body of knowledge
 - Delivery format
 - Student-centered learning
 - Case studies

- What topics should be addressed?
 - Technical, process, organizational, contextual?
- Should training be developed in-house or bought from a vendor or university?
- Are alternatives to classroom training effective? Under what conditions?
 - Mentoring, on-line, guided self-study, on-the-job?
- How should training be paid for?
- How do you determine whether training is effective?
- How much SE training is enough?

Who is the Target Audience?



Junior SEs and component engineers

- Seeking to broaden their understanding of SE, as it applies to their tasks



Support personnel

- Seeking to understand SE, to support more effectively



Senior SEs

- Seeking to effectively manage the SE process

- Student background and experience
- Student expectations
- Overhead vs. student time

Is the Staff Qualified to Do Their Work?



An organizational responsibility!

- What are the minimum skills and knowledge needed to perform their job function?
- Does each individual possess these skills?
 - If not, training should address the gaps

How does the organization maintain a skilled and knowledgeable workforce?

Competency Model

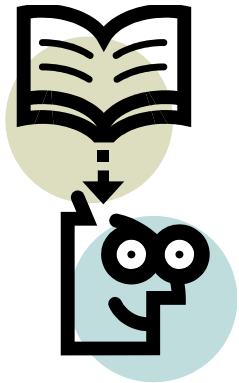
- A competency is a set of behaviors encompassing skills, knowledge, abilities, and personal attributes critical to successful performance at a particular job
 - Should be observable and measurable through behaviors
 - These behaviors provide a model for superior job performance
- Can provide a powerful mechanism for identifying gaps in individual and workforce-wide skills sets, identify appropriate training
- Must be integrated with an organization's strategic goals and individual performance plans



Strategies for Organizational Training - 1



- Start by defining the key job functions in the organization
 - E.g., project manager, software engineer, quality assurance specialist

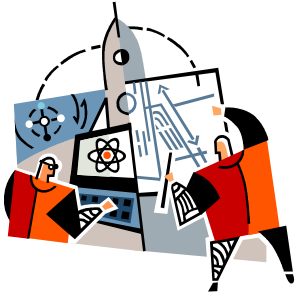


- Identify the requisite knowledge associated with each function
- Define a set of course modules that impart this knowledge
 - Map modules to job functions
 - Some modules will be common to multiple job functions



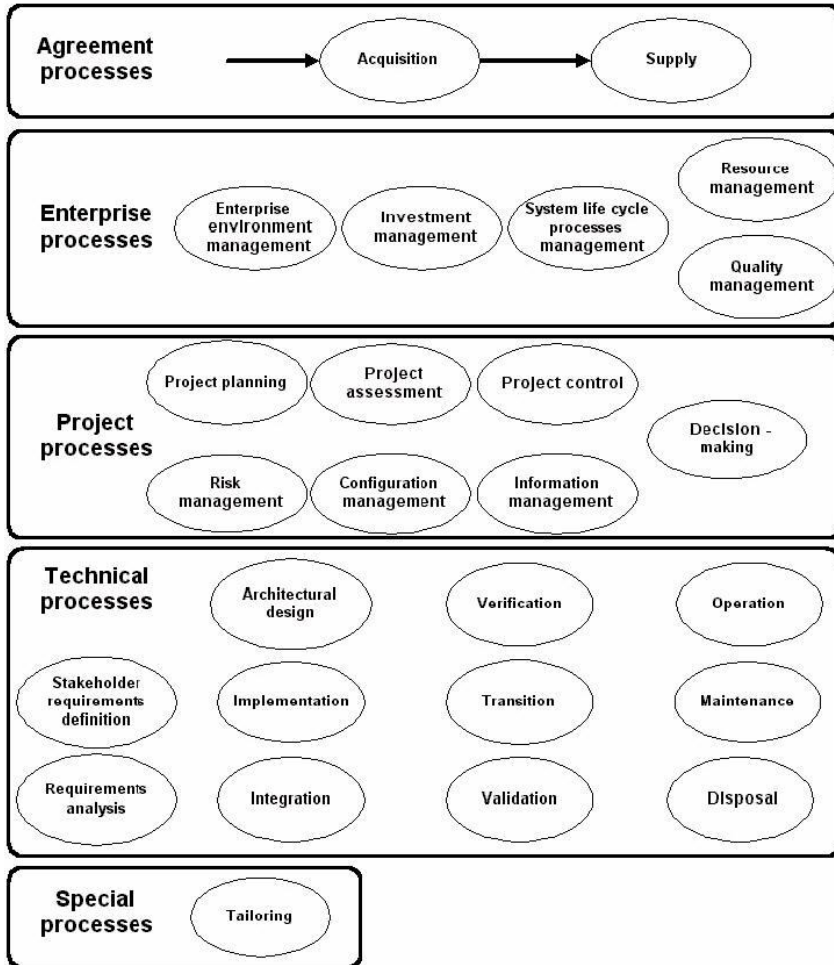
- Acquire training materials and trainers
 - Should reflect the organization's policies and processes
 - Unlikely that standard vendor/university courses will fit

- Identify each employee by their job function(s), map to required courses
 - If the employee already has the identified minimum knowledge, they do not need to take the course
- Establish student records
 - Who has completed what course, waivers
- Review required training with employees
 - Career-planning, promotions, new hires
- Add project-specific training (e.g., tools, methods), where needed



Body of Knowledge

System Life Cycle Processes ISO/IEC 15288



Government/commercial standards (e.g., MIL-STD-499C, INCOSE SE Handbook, SEBoK, ...)

System engineering discipline vs. engineering a system

Organizational-specific topics

- Processes and procedures
- Tools and methods
- Customer acquisition practices
- Domain-specific technologies

Andragogy - Learning strategies focused on adults

- **Need to Know** - Adults need to know the reason for learning something
- **Foundation** - Experience (including error) provides the basis for learning activities
- **Self-concept** - Adults need to be responsible for their decisions on education; involvement in the planning and evaluation of their instruction
- **Readiness** - Adults are most interested in learning subjects having immediate relevance to their work and/or personal lives
- **Orientation** - Adult learning is problem-centered rather than content-oriented
- **Motivation** - Adults respond better to internal versus external motivators

Knowles, Malcolm; Holton, E. F., III; Swanson, R. A. (2005). *The adult learner: The definitive classic in adult education and human resource development* (6th ed.)



Traditional Instructor-Led

- Instructor as recognized authority, constant lecturer, and master of the classroom
 - Student as passive receptor
- Instructor presents course content primarily through lecture
- Assessment verifies that course content was memorized



Student-Centered Learning

- Student is responsible for their own learning, proactively identifies gaps in knowledge, how best to learn
 - Teacher as guide
- Goal is for the student to develop the skills needed to explore and use the information
- The student explores and applies content, with instructor and fellow students providing feedback

Student-Centered Teaching Styles

- Read-ahead material
- References for further study
- Students help identify topics, depth of instruction
- Students review material and teach others
- Class projects
- Case studies

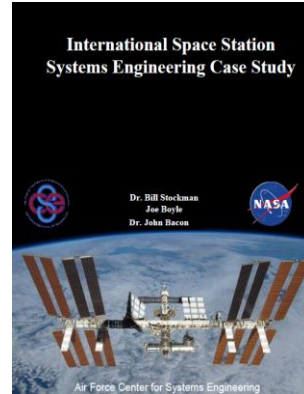


- Case studies provide an opportunity for students to see the real-life application of SE principles and tools
 - Bad examples often just as instructive as good examples
- Require participation and integration of a broad set of skills

USAF SE Case Studies

<http://www.afit.edu>

- A-10 Thunderbolt
- B-2 stealth bomber
- C-5 military transport
- E-10A MC2A aircraft
- F-111 aircraft
- Global Hawk drone
- Global Positioning System (GPS)
- Hubble Space Telescope
- International Space Station
- KC-135 simulator
- Large Aircraft Infrared Countermeasures
- MH-53J/M PAVE helicopter
- T-6A Texan II aircraft
- Theater Battle Management Core System (system-of-system command and control)



	Responsibilities		
	Contractor	Shared	Govt.
Requirements Definition and Mgmt			
Systems Architecture Development			
System, Subsystem Design			
Validation and Verification			
Risk Management			
Systems Integration & Interfaces			
Life Cycle Support			
Deployment and Post Deployment			
System and Program Mgmt			

- Student individual motivations greatly effect the degree of learning
- The classroom setting provides a low risk environment conducive to learning
- Students value an understanding of the overall SE process and an SE perspective
- Class projects provide practical feedback on implementation details, team dynamics
- SE training can encourage further study and connections with other functional areas on the students' current project

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