

# Applying Systems Engineering to Workforce Development

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Richard B. Pearlstein, PhD

CSM Director, Organizational Effectiveness

Ken Mosteller,

CSM President

# How do we develop systems engineering (SE) curricula?

- Typically, organizations build internal SE workforce development curricula by a consensual knowledge-sharing process
- Senior Systems Engineers identify behaviors they think are critical to their success.
- This results in a complex schema of subject matter-related facts, concepts, and principles

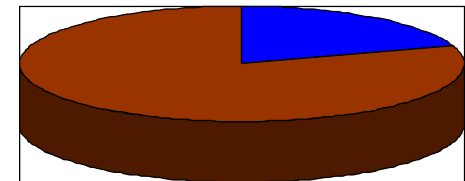
# How should we develop a curriculum?

- First, determine if we need an SE curriculum. Ask “Could new systems engineers do the targeted tasks if their lives depended on it?”
  - If the answer is “Yes, many could in many cases,” then an SE curriculum may NOT be the primary requirement
- If they could do the tasks, but often don’t, ask “What is blocking performance?” It may be a lack of:
  - Clear instructions & management direction,
  - Environmental support & tools for desired behaviors,
  - Appropriate consequences for and feedback on behaviors

# If we need to develop an SE curriculum:

- We should use an SE approach
  - Start by determining requirements for effective systems engineering in your organization
  - Conduct a systematic task analysis
    - Use the Pareto Principle
    - Roughly what 20% of SE behaviors account for about 80% of on-the-job SE activities
  - A curriculum should address these 20% AND any additional mission-critical behaviors

Project Activities



- % of SE behaviors accounting for 80% of all activities
- % of SE behaviors accounting for 20% of all activities

## How should we focus a curriculum for new systems engineers?

- First, of the most common activities, which can most new systems engineers already do well?
  - Training need not focus on these activities
- Then determine which activities most new systems engineers cannot yet do well
  - To do this, start by determining what differentiates exemplary performance on those activities from ordinary performance

# Exemplary performance & exemplars

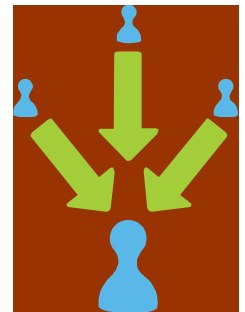
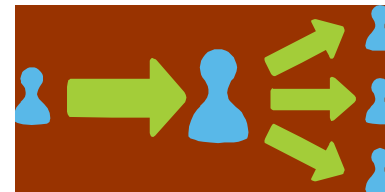
- Exemplary performance is done by people currently doing the job the way managers want it done
  - Working with exemplars is a process detailed by Thomas Gilbert in a book is called: ***Human Competence: Engineering Worthy Performance***
  - Exemplars are usually NOT subject matter experts (SMEs)
    - In most organizations, SMEs are supervisors or specialists who are NOT currently doing the job
    - Once people stop doing a job, they no longer have to struggle with how to get things to work given current situations
    - Exemplars are in the best position to know what really works

# Develop a performance-based curriculum

- Why do we usually use a subject matter-based approach?
  - From kindergarten on, our education focuses on subject matter
  - We are conditioned to think that:
    - Knowledge = performance
    - The more we know, the more we can do
- But ***know-how*** is different from ***know-about***
  - This is NOT to say that knowledge is unnecessary
  - But it IS to say that performance is critical
- So work with exemplars and focus on:
  - What systems engineers need to DO, as opposed to what they should know
  - APPLICATION of concepts instead of general conceptual knowledge

# What skills will the curriculum address?

- **Varies according to an organization's needs:**
  - Systems engineers' skills differ across organizations
  - Systems engineers' roles differ across organizations
  - Organizations have different kinds of stakeholders & missions





# Examples of SE skills



## ■ Technical skills

- Developing a suitable systems architecture
  - In our organization, what do exemplary systems engineers do to develop effective architectures that is different from what ordinary systems engineers do?

## ■ People-oriented skills

- Achieving consensus with multiple stakeholders
  - In our organization, what do exemplary systems engineers do to establish consensus that is different from what ordinary systems engineers do?



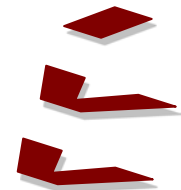
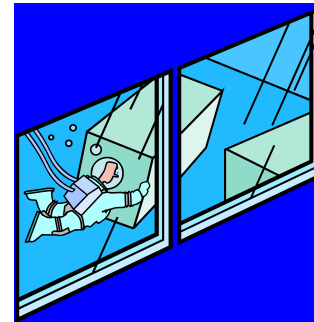
# How should we test & evaluate?

## ■ A curriculum built in an SE way requires:

- Integration
- Verification
- Validation

## ■ Testing should determine:

- Are the right SE skills being taught?
- Are they being taught right?
- Are they being used on the job?
- Are they improving mission success?



## In other words, testing & evaluation should:

- Assess the degree to which targeted SE behaviors occur
- Determine the extent to which they occur to standard and under the right conditions
- Ensure that performance occurs during both
  - testing, and
  - mission performance
- Assess the degree to which that performance contributes to mission performance

# Why don't we develop SE curricula in an SE way?

- Many think costs would be prohibitive
- Many think a subject-matter based approach is appropriate: “We’ve always done it this way”
- Some think SE doesn’t apply to workforce development issues
- Sometimes the cobbler’s kids just go barefoot



# A question of costs



- Upfront costs for developing SE curricula using SE principles WILL cost more than usual
- But delivery time and costs can be cut dramatically because the curriculum can focus sharply on:
  - The right behaviors
  - Done right
- So, developing SE curricula using SE principles is usually an effective approach for:
  - Large organizations with many systems engineers
  - Critical projects on which systems engineering excellence is the key to success

# Performance- vs. subject matter-based

Although we may have always done it in a subject matter-based way, remember that:

**"Know How"  
is different than  
"Know About"**

## Systems engineering applies to workforce development when:

- Competent systems engineers are important to the organization's mission
- Performance targets must be met
- Competence must be built and maintained
- In other words, if we know enough to apply systems engineering to important projects, than we should know enough to apply it to our important workforce development needs

# The costs of systems engineers going barefoot

- **When we do not invest in effective development for our systems engineers:**
  - We do not specify their learning requirements in terms of actual performance needed on the job
  - And, we cannot measure their job performance in terms of skills and standards, which means,
  - We cannot select, develop, and plan their career paths effectively
  - Nor can we help them move from good to exemplary performers



# SE “shoes” for system engineers

- **SE shoes help systems engineers by:**
  - Giving them a map of what is expected of them
  - Showing them the way to build their SE skills
  - Helping them learn the “tips and tricks” that exemplary performers use in their specific work environments
  - Letting them know how their SE performance will be assessed



# Suggested reading

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# Contact Information

## ■ Rich Pearlstein

571-218-8573

The Center for Systems Management

[rpearlstein@csm.com](mailto:rpearlstein@csm.com)

## ■ Ken Mosteller

703-852-3330

The Center for Systems Management

[kmosteller@csm.com](mailto:kmosteller@csm.com)