Applying Systems Engineering to Workforce Development

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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
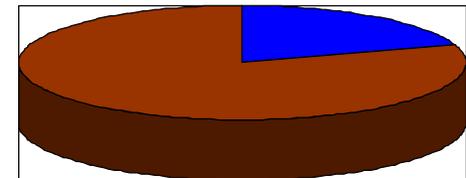
How should we develop a curriculum?

■ 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
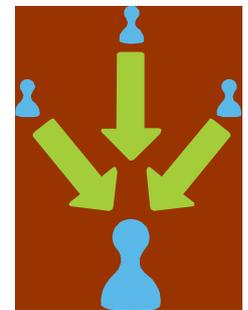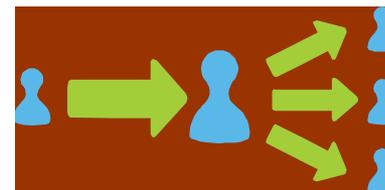
Examples of SE skills

- ## 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?
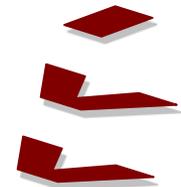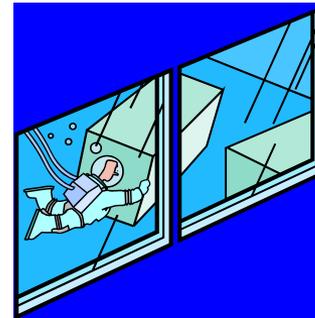
How should we test & evaluate?

- 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?

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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

early

later

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"

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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

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Suggested reading

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