Accelerate Performance Improvements: Systems Engineering Skills Competency Analysis and Training Program Development

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General Dynamics, Land Systems
Agenda

- GDLS Overview
- SE Training & Education Program Overview
- Competency Assessment
- Gap Analysis
- Curriculum Development
- Results to Date
- Future Activities
GDLS Mission

General Dynamics Land Systems provides a full spectrum of land and amphibious combat systems, subsystems and components worldwide.

Our strengths are world-class design and systems integration, superior production and innovative life cycle support.

We will deploy these strengths to meet our customers’ needs in a changing world.
Major Contributors to Poor Program Performance*

- Lack of technical planning and oversight
- Inadequate understanding of requirements
- Incomplete, obsolete, inflexible and Stovepipe Physical and Functional architectures
- Stovepipe developments with late integration
- Lack of subject matter expertise at the integration level
- Low visibility of software risk

Lack of systems engineering discipline, authority, and resources

* DoD-directed Studies/Reviews, 2005
GDLS’s Response

- Organize along Product Centers
  - Voice of customer
- ‘One Engineering Design and Development Team’ for GDLS
  - Integrated Process System across all Locations
  - CMMI Level 3/5
- Revitalize Systems Engineering
  - Process Improvements
    - Gate Reviews, Six Sigma, DFR
  - SE Training & Education Program

Today’s Topic
SE Training & Education Program
Development Overview

- Roles identified for Systems Engineering
- For each role, required competencies established
- Employees assessed against required competencies for their assigned roles
- Results of competency assessments analyzed to identify gaps
- SE Curriculum developed to address high and medium gaps and to further develop employees with low or no gaps
- Training Plan developed to incorporate SE Curriculum, mandatory courses, and Seminars/Conferences
- Progress to goals and training effectiveness measured by Level 1 evaluations
Competency Assessment

- Supervisor verifies that correct roles are assigned to Employee
- Employee conducts self-assessment of competency levels for each required competency
  - **Basic** - Trained or understands basic concepts of the competency, however still needs help in applying the competency
  - **Qualified** - Has a good command of the competency, no help needed in applying the competency
  - **Advanced** - Has advanced understanding of the competency, can lead and/or teach others in applying the competency
  - **None** – Does not meet basic competency level
- Supervisor verifies assessment
- Training Coordinator compiles all completed assessments
- Training Coordinator evaluates roles to determine which roles represent 80% of the Systems Engineering population
Gap Analysis Methodology

- Determined which roles represent 80% of the SE population (top roles)
- Identified top 20 required competencies for the top roles
- Analyzed results of competency assessments to determine distribution of gaps across the top roles for the top 20 required competencies

Gap Analysis
(Compared Required Skill Level to Evaluated Skill Level)

- High Gap
- Medium Gap
- Low Gap
- No Gap
Competency Assessment Results

- **Highest Gap**
  - SE Principles
  - Project Management
  - Domain Specific Skills

- **Medium Gap**
  - Risk Analysis
  - Test & Validation Planning
  - Baseline Management (CM)

- **Lowest Gap**
  - Requirements Management
  - Trade Studies
  - Reliability
  - Design Integration
SE Curriculum

Low or No Technical Gaps

SSCI SE Certificate Program
By 2011:
10% Earn SSCI SE Certificate (68 total)

Certified SE Professional (CSEP)
By 2011:
10% Earn INCOSE CSEP (68 total)

High & Medium Technical Gaps

SE Overview/SE Principles
By 2011:
100% Complete SE Overview/Principles (676 total)

Basic Configuration Management
In 2008:
25 students complete Basic Configuration Management

Knowledge Retention & Development
Risk Analysis
Succession Planning
Succession/Leadership Development
Conferences & Seminars

Design for Six Sigma
Master Black Belt TTT
DFSS Green Belt Program

Design for Reliability Curriculum
Developed with outside vendor (Air Academy) to be delivered in-house by GDLS Six Sigma & Emerging Methods

Cross Functional Development
Rotational job assignments:
- Logistics Engineer
- LSE
- Section Manager

SE Re-Vitalization – Skills & Organizational Feedback

* Based on 676 SE employees (Contractors not included)
Development of SE Training Plan

- Technical Competency Gaps
- SE Curriculum
- Technical Conferences & Seminars (Debriefs Conducted)
- SE Organizational Training Plan (OTP)
- ED&D Organization Training Plan (OTP)
  - Mandatory Health & Safety, ITAR,
  - ED&D Imperatives
- Available budget
Training Budget Distribution

- Training represents 6% of the Systems Engineering overhead budget.

Year to Year Training Hours Distribution by Category

- **Mandatory Training** includes health, safety and security courses.
- **Non Technical Training** includes courses such as leadership development, teaming, CMMI and ISO.
- **Technical Training** includes courses such as SE Certificate Program/Overviews, GD&T, Soldering and Welding.
Development of SE Courses

2006
- Training Gap Analysis of Systems Engineering employees revealed need for Systems Engineering courses.
- Completed trade study and selected Center for Systems Management (CSM) based largely on their affiliation with Stanford University.
- Delivered first sessions of SE courses with CSM.

2007
- CSM/Stanford University no longer affiliated.
- Second trade study conducted to determine if vendor change best option for future course delivery.
- Systems and Software Consortium (SSCI) selected based on reputation and prior relationship.
- Collaborated with SSCI to tailor standard course materials for GDLS.
- Delivered first sessions of 12-day SE Certificate Program (SECP).

2008
- Continued offerings of SECP and added 5-day and 2-day SE Overview course to training plan.
- Utilized Michigan Economic Development Grant
Training Goals

SE Certificate Program
- Projected and Actual students trained by year (2007-2011)

Certified SE Professionals
- Projected and Actual employees certified by year (2007-2011)

SE Principles
- Projected and Actual students trained by year (2006-2011)

SE Concepts/Principles Skill Gap Burndown
- % Gap Remaining and Linear (% Gap Remaining) by year (2006-2011)
Training Evaluation

Levels of Evaluation

1. Reaction
   - Measures: Students reaction to the training
   - Tool: Surveys

2. Learning
   - Measures: Extent to which students have advanced skills/knowledge
   - Tool: Pre- and Post-tests

3. Application
   - Measures: The transfer of skills/knowledge to employees’ work
   - Tools: Employee competency level assessed by Supervisor, Employee confidence level self-assessed

4. Results
   - Measures: Impact of training on business performance
   - Tools: Average Competency Level of students vs. Delivery Cost per student, process performance measures
Results to Date

- Development of evaluation methods: surveys, pre/post testing, 90-day evaluations
- Evaluations reveal effectiveness of courses
- Student comments used to improve future course delivery
- Modest changes to 2006 SE Training Gap
SE Training Effectiveness

- Level 1 Evaluation: Course Surveys administered at end of class
  17 question survey used to evaluate students’ satisfaction with the course content, instructor, resources, and relevance of course to their jobs.

EXAMPLE COURSE 1

EXAMPLE COURSE 1:
ANALYSIS

- Some attendees were employees with many years of experience and felt that the course was not relevant to them.
- Course material needs to be made more relevant to SE. Too much focus on Software.

CORRECTIVE ACTION

- One time offering. No action to be taken at this time. If future offerings to be scheduled, consider tailoring course material to SE and use updated gap analysis data to identify attendees.
# SE Training Effectiveness

## Level 2 Evaluation: Pre/Post Testing

Test of 10 questions based on course content administered at start and end of courses to measure initial effectiveness of course delivery.

### SE Overview 5 Day Pre/Post-Test

Class Held: 8-18-22-08 – VIS Room

<table>
<thead>
<tr>
<th>Employee #</th>
<th>Pre-Test</th>
<th>Post-Test</th>
</tr>
</thead>
</table>

Please take a few minutes to answer the questions below to the best of your ability. This is a two-part exercise with the purpose of measuring the basic skills/knowledge gained through this course. You will be asked to complete this same test at the end of the course. There is no penalty for wrong answers.

**Possible Answers:**
- Maintenance
- Process Control
- State
- Measures of Effectiveness
- Quality
- Systems Engineering
- Mode
- Reliability
- Validation
- Planning
- SEMP
- Verification

**Fill in the blanks using the choices above.**

1. ____________ is an interdisciplinary approach and means to enable the realization of successful systems.
2. ____________ are used to quantify the performance of system products and processes.
3. ____________ is the condition of the system.
4. ____________ is the manner in which the system operates.
5. ____________ and ____________ are elements of Logistics Support.
6. ____________ answers the question, “Did we build the right thing?”
7. ____________ describes engineering specialty integration, the SE work to be done, and the management of this work.
8. ____________ and ____________ are engineering specialties.

### EXAMPLE COURSE 2: ANALYSIS

- Few students scored higher on Post Test
- Focus of course did not match pre/post test questions well.

### CORRECTIVE ACTION

- Prior to next course offering, work with course instructor to develop a Pre/Post test that is more relevant to the topics reviewed during the course.
SE Training Effectiveness

- Level 3 Evaluation: Application – Post-Course Evaluation

Use standardized evaluation form to collect data.

Send via email to students 60-90 days following course.

Measures frequency of skill use, value of skill on job, self-assessed proficiency rating, barriers to use on job.

EXAMPLE COURSE 3: ANALYSIS

- Analysis of preliminary data shows course is well received and is perceived by attendees to have value in their day to day activities. Most students would recommend this course to coworkers and managers.
Path Forward

- Complete follow up Training Gap Analysis by year-end
- Renew focus on closing identified training gaps
- Continue to tailor/modify course delivery based on student feedback
- Continue to develop and improve evaluation methods to assess improved business performance
Contact Information

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BACKUP
# Roles & Competencies

## ROLES REPRESENTING 80% OF SE POPULATION

<table>
<thead>
<tr>
<th>Role</th>
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<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements Engineer</td>
<td>Configuration Management (CM) Engineer</td>
<td>Specialty Engineer - Embedded Training Analyst</td>
</tr>
<tr>
<td>Section Manager</td>
<td>Team Lead</td>
<td>Administrative Assistant</td>
</tr>
<tr>
<td>Systems Analysis Engineer</td>
<td>Corrective Action Engineer</td>
<td>Environmental Test Technician</td>
</tr>
<tr>
<td>Physical Architect</td>
<td>System Integration Engineer</td>
<td>Process Engineer</td>
</tr>
<tr>
<td>Specialty Engineer</td>
<td>System Integration Engineer</td>
<td>Proxioning Analyst</td>
</tr>
<tr>
<td>Field Test Engineer - Vehicle Test Engineer</td>
<td>Environmental Test Engineer</td>
<td>Training Content Developer</td>
</tr>
<tr>
<td>System Architect</td>
<td>CM Technician</td>
<td>Requirements Management Analyst</td>
</tr>
<tr>
<td>Logistics Engineer</td>
<td>Field Material Supply Specialist</td>
<td>Field Test Engineer - Supply Support Engineer</td>
</tr>
<tr>
<td>Lead System Engineer</td>
<td>Maintenance Engineer</td>
<td>Logistics Engineering Liaison</td>
</tr>
<tr>
<td>Reliability Engineer</td>
<td>Department Manager</td>
<td>System Safety Engineer</td>
</tr>
<tr>
<td>Technical Writer - Operations and Maintenance</td>
<td>Diagnostics Engineer - Troubleshooting Developer</td>
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</tbody>
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## TOP 20 COMPETENCIES

1. System Engineering Principles
2. Job Specific Process knowledge
3. Product knowledge - (Tracked, Wheeled or FCS as applicable)
4. Customer Satisfaction
5. Communication
6. Effective meeting / reviews
7. EVMS
8. Risk Analysis
9. Trade Studies
10. Reliability theory
11. Pro E
12. DOORS
13. Requirements Generation & Documentation
14. Metric development
15. Program Management
16. Test & validation plan development
17. Cost estimating / proposal development
18. DFMEA principles & techniques
19. XFMEA (reliaisoft suite of tools - Vmetric, Weibull, blocksim)
20. Project Planning
SE Certificate Program (SECP)

- Is an on-site program leading to a Systems Engineering Certificate from the Systems and Software Consortium, Inc. (SSCI).
- Is an intensive, graduate-level learning curriculum for experienced, practicing engineers.
- Is a 12 day program delivered in a building block approach of four 3-day modules over a two to three month period with self-study, classroom, and team project work.
- Is a program that integrates INCOSE SE Handbook material in an effort to help participants who are interested in pursuing the INCOSE Certified Systems Engineering Professional (CSEP) certificate.
- Provides the ability to address skill/competency gaps through training
- Supports SE Revitalization
SE Certificate Program (SECP)

SE Certificate Curriculum (4 classes, 3 days each)

Define the Problem
- SE Planning
- Needs, expectations and constraints
- Concept of Operations

Define the Solution
- Architecting and Synthesis
- Allocation
- Cost Factors
- Analysis and Decisions
- Specialty Engineering
- Integrated Product Teams

Close the Loop
- Verification
- Validation
- Integration
- Deployment
- Logistics Support

Manage the Work
- SE Management
- Organization & Systems
- Engineering
- Risk & Opportunity Management
- Technical Parameter Measurement
- Work Breakdown Structure
- Earned Value Management
- Scheduling
- Process

Other SE Courses

SE Principles

- Is an on-site course developed by the Systems and Software Consortium, Inc. (SSCI).
- Offered as 2 and 5-day courses
- Provides overview of SE for inexperienced engineers (high or medium technical competency gap).
- Describes the basics of systems engineering – what it is, how it proceeds through the life cycle and why it needs to be done.

Basic Configuration Management

- Is a two-day, on-site course developed by the Systems and Software Consortium, Inc. (SSCI).
- Provides a foundation in basic Configuration Management principles and skills
Certified SE Professional

Certified Systems Engineering Professional is a recognized certification that confirms that an individual has the basic skills to perform fundamental Systems Engineering tasks and is able to make a productive contribution to work efforts.

Benefits of CSEP Certification
- Formally recognizes SE capabilities
- Distinguishes CSEP holder from others within a professional field
- Provides a competitive advantage
- Furthers professional SE development
- Helps advance the art and practice of SE

Certification Process