Tools and Resources to Enable Systems Engineering Improvement

Michael T. Kutch, Jr.
SPAWAR Systems Center Charleston (SSC-C)
Head, Intelligence & Information Warfare Systems Engineering Department
National Competency Lead for I/A 5.8
Deputy National Competency Lead for ISR/IO 5.6

Mike Knox
Technical Software Services, Inc.
Director, Implementation and Support
SEI Authorized Instructor

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Improving operational effectiveness through C^4ISR common integrated solutions
Vision and Strategy
- Elements of Implementation

Process Asset Library

Tools
- ePlan Builder and eWBS
- Organizational Measurement Repository

Training
- Training Architecture
- Courses

Results

Going Forward
• Vision
  – Develop and maintain a World Class Systems Engineering Organization

• Approach
  – Achieve Command-wide operational consistency
  – Based on ISO 15288 – systems engineering
  – Based on ISO 12207 – software engineering
  – Measure using best practices of CMMI®

• Goals
  – CMMI Maturity Level 2 by April, 2005
  – CMMI Maturity Level 3 by April, 2007

Both Goals attained on schedule
1st SPAWAR Systems Center to Achieve ML2 and ML3
New Goal: Maturity Level 4 by 2010
Which one is World Class?

When you want it done right, Who do you want working on it?

Cutting corners, undisciplined, untrained

Rigorous processes, Skilled resources

Permission to use Redneck Mechanic photo received from Dave Lillgren, 3/9/2007
Permission to use NASCAR Technical Institute photo received from Popular Mechanics, 3/16/2007
<table>
<thead>
<tr>
<th><strong>CRITICAL SUCCESS FACTORS FOR SE REVITALIZATION</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Command-wide Policy</strong>&lt;br&gt;(Create vision that is urgent)</td>
<td><strong>Assign Responsibilities</strong>&lt;br&gt;(Strong Change Agents are essential)</td>
</tr>
<tr>
<td><strong>Strategy and Plan</strong>&lt;br&gt;(Include knowledge of why change is necessary and benefits)</td>
<td><strong>Provide Training</strong></td>
</tr>
<tr>
<td><strong>Senior Management Support</strong></td>
<td><strong>Build Central Repository</strong></td>
</tr>
<tr>
<td><strong>Provide Resources and Funding</strong>&lt;br&gt;(New Organizational Structure Usually Needed)</td>
<td><strong>Measure and Communicate Progress</strong></td>
</tr>
</tbody>
</table>
SSC-C SE Revitalization Plan
Aligned with DoD SE Revitalization

Elements of SSC-C SE Revitalization

Policy / Guidance
- SSC-C SE Instruction
- SSC-C SE Process Manual
- SSC-C SW-Dev Process Manual
- SSC-C SW-Maint Process Manual
- EPO Website
- ePlan Builder

Training / Education
- Intro to PI WBT
- SE 101 WBT
- SE Fundamentals
- SE for Managers
- Project & Process Workshop
- Intro to Software Engr.
- Architecture Dev. WBT
- Certification/Degrees

Assessment & Support
- CMMI® Level 2
- CMMI® Level 3
- CMMI® Level 4/5
- Project Reviews
- Balanced Scorecard
- Lean Six Sigma
- Integrated Product Teams
- IT Tools

Underway
Completed/Ongoing
• Supports the Director of Engineering Operations
• Developed Policies
  – Policy for each CMMI Level 2, 3, 4, & 5 Process Area
• Developed Standard Process Manuals
  – Top Level
    • Systems Engineering
    • Software Development
    • Software Maintenance
  – Supporting Processes
    • Process Manual for each CMMI Level 2, 3, 4, & 5 Process Areas
    • Additional process documentation as needed – Reviews, Tailoring, etc
• Develop plan templates
• Coach and mentor selected projects
• Build tools
• Develop and deliver training
• Perform interim assessments
Recognized early need for central repository for Organizational Process Assets
EPO website provides access to all of SSC-C’s organizational process assets

Approximately 100 pages of content; over 1000 documents available

EPO Home

Welcome to the SPAWAR System Center - Charleston’s Engineering Process Office (EPO) Homepage. This site is the repository for a wealth of systems engineering, software engineering, and process improvement information to aid our vision in becoming a world-class systems engineering organization.

The site contains the SSC-Charleston Organizational Process Assets, including the organization’s set of standard engineering processes and procedures, tools, sample documents, templates, and project guidelines. The measurement repository of project and process measures is also accessible.

The site also contains information about the Capability Maturity Model for Integration (CMMI®) and SSC-Charleston’s commitment to process improvement. The CMMI® is used to benchmark and measure our process improvement progress against industry best practices.

Background

SSC-C is committed to process improvement and has been actively pursuing process improvement since 1995. SSC-C is implementing the Capability Maturity Model for Integration (CMMI®). The IDEAL® model is being used to implement process improvement.

- SSC-C’s commitment to process improvement and policy regarding it were re-affirmed in a SSC-C command-wide Process Improvement Policy dated 11 December 2003.
- Navy Endorses CMMI as the Standard Process Improvement Model
- ASN RDA Software Process Improvement Initiative

The information below describes what will be found under each major section of the site.
Each CMMI process area has a standard page with links to policy, process manual, SOPs, Sample/Project documents, and other resources.
Projects Section

Each appraised project has a page and is expected to share good examples of plans and documents.
Tools

- ePlan Builder
- Organizational Measurement Repository
- Appraisal Wizard
ePlan Builder tool

- An interactive, web-based application that leads the user through a structured interview process (like TurboTax®) to generate a CMMI®-compliant plan
- Includes standard, consistent text
- Generates an initial project-specific document
  - Project Management Plan (with Work Breakdown Structure)
  - Configuration Management Plan
  - Process and Product Quality Assurance Plan
  - Requirements Management Plan
  - Measurement and Analysis Plan
  - Supplier Agreement Management Plan (by end of 2007)
  - Systems Engineering Plan (DoD SEP Format)
Tailor each role from pre-defined list of tasks and/or add custom tasks

EPB – Select Tasks for each Role

Project Leader Tasks

The Project Leader is responsible for establishing and maintaining the project plan.

Please identify the specific responsibilities of the Project Leader.

- Coordinates all activities of the prime contractor and subcontractors
- Assigns specific responsibilities to subcontractors [FP GP 2.4]
- Discusses technical issues from the Government with subcontractors
- Discusses technical issues from the subcontractors with the Government
- Manages the project cost and schedule [PMC 1.1]
- Resolves any inconsistencies in the requirements [PMC 2.2]
- Mitigates project risks [PMC 1.3]
- Manage and resolve corrective actions [PMC 2.2] [PMC 2.3]
- Provides prime contractor and subcontractor work products and deliverables to the Government

Please enter any additional specific responsibilities of the Project Leader.

Task

Note mapping to CMMI® generic and specific practices
Work Breakdown Structure (WBS) in a Project Management Plan

Choose the WBS Source

Add Previous Fiscal Year

000 Leadership/Management
  001 Leading
  002 Management
  003 Personnel Management Activities
  004 Communications

100 Project Management
  110 Management Documentation
    111 Programming & Budgeting
      2007 $200
    112 Program Planning Documents
      2007 $200
    113 Acquisition Documents
      2007 $100

Add Fiscal Year

2007
  000 Leadership/Management
    001 Leading $500
    002 Management $900
    003 Personnel Management Activities $500
    004 Communications
  100 Project Management
    110 Management Documentation
      111 Programming & Budgeting 2007 $500
      112 Program Planning Documents
      113 Acquisition Documents

Cost estimates entered using the SPAWAR global WBS or the SSC-C Activity Based Costing WBS

ePB accommodates multi-year projects

Can drill down three levels deep in WBS structure. Costs sum up to higher level.
Risks

This page allows you to enter a list of known or expected risks. The severity of the risks and the mitigation approach for each should be identified. Please use the table below to identify the major risks associated with the project.

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Impact/Concern</th>
<th>Level</th>
<th>Mitigation Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule</td>
<td>Products are required by the customer by 10/1/06</td>
<td>High</td>
<td>Be prepared to provide draft materials if development of</td>
</tr>
<tr>
<td>Quality</td>
<td>Will products be ready for 10/15/06 in a condition</td>
<td>Medium</td>
<td>Provide technical data to contractor in accordance with schedule with</td>
</tr>
<tr>
<td>Technical</td>
<td>Ability to get teh technical ata from the</td>
<td>High</td>
<td>Interact directly with the satellite manufacturer to obtain the technical</td>
</tr>
</tbody>
</table>

PMP may also reference a more comprehensive Risk Management Plan
Cost is a measure within the Financial Performance category that measures the cost for activities, events, and products. The measure provides an easy-to-understand view of the budget. Comparison of planned and actual cost data provides insight into significant and repetitive cost changes at the activity level.

While more detailed cost information provides more insight into the project's total cost, until the project personnel have achieved a certain level of proficiency in estimating costs, it is recommended that the cost data should be captured at a level commensurate with this level of experience.

Collection and Storage

Identify the level of detail for capturing cost data:
- Project Level

Please select how the Project Leader will report contract costs from the list below. If the Project Leader is not responsible for managing contracts, select "Project".
- Project

Identify who will provide the actual cost data:
- Project Leader

Identify the tool to be used to collect cost data:
- BSA and PMACS

Identify how often the actual cost data will be collected:
- Monthly

Analysis Procedures

Identify how often the cost data will be analyzed:
- Monthly

Identify the cost alert threshold:
- 95%
SEP format follows the DoD SEP Preparation Guide

Next Life-Cycle Phase

The SEP requires that the program’s acquisition history and life-cycle phase be discussed, describing the top-level, technical process used in each life-cycle phase. This Next Life-Cycle Phase section should give an overview of the next planned life-cycle phase as well as summarize the process activities that are expected to be finished during the next life-cycle phase.

Please enter text discussing the Next Life-Cycle Phase of the program.

This description should give an overview of the planned SE process and should have more detail than the historical life-cycle processes completed. It should include how the technical process will be integrated into the life-cycle model and summarize the process activities that are expected to be finished during the next life-cycle phase.

Life-Cycle Phases (in hierarchical order):

1. Concept Refinement
2. Technology Development
3. System Development and Demonstration
4. Production and Deployment
5. Operations and Support
Design Considerations

This section describes any design considerations that must be integrated into the engineering design effort including any special constraints that must be considered.

Please enter any design constraints.

These design constraints are any special considerations that must be taken into account before they are integrated into the project during the engineering process. The text should also describe the basis for these design constraints and how the technical authority is going to be engaged in considering and integrating these constraints.

Some examples of design constraints are as follows:

- The system shall be able to operate using the three phase power available on board a ship.
- The system shall be able to fit into a standard 19" rack.

While these constraints look like requirements, they are not system requirements because they do not specify what the system must do, nor do they specify how well the system must perform a capability; they constraint the possible solutions by limiting the choices available to the engineers, and are therefore design requirements that constrain the solution space.

The nature of the SEP requires more open input text fields, but EPB helps by providing elaborations and examples for the user.
Trade Studies

This section should include a brief description of the process used to determine trade-offs between various attributes of the program (e.g., between requirements and design). Information about how trade studies are addressed within the organization will be automatically embedded into the document. To view the embedded information about how trade studies will be addressed, click the "Click to view the embedded trade studies text" link below.

Click to view the embedded trade studies text.

Trade studies will be addressed in accordance with the SSC-C Technical Solutions Process Manual and SSC-C Decision Analysis and Resolution Process Manual where the development of alternate solutions, selection criteria and trade processes are discussed.

The actual trade studies to be performed on the program will be captured and listed in the control below.

Please enter the trade studies that will be conducted on this program.

Trade Study
Research on OSP topologies

Trade Study
Research on different conduit installation
Table of Contents

1. Introduction
   1.1 Program Description and Applicable Documents
   1.2 Technical Status as of the date of this SEP...
   1.3 Approach of SEP Updates

2. System Engineering Application to Life-Cycle Phases
   2.1 Acquisition History
      2.1.1 Previous Life-Cycle Phases
      2.1.2 Next Life-Cycle Phase
   2.2 System Capabilities, Requirements and Design Considerations
      2.2.1 System Capabilities
      2.2.2 Certification Requirements
      2.2.3 Design Considerations
   2.3 SE Organizational Integration
      2.3.1 Organizational Roles
      2.3.2 Program Roles and Responsibilities
   2.4 Training
   2.5 System Engineering Process
      2.5.1 Planning
      2.5.2 Process Improvement
      2.5.3 Modeling and Simulation
      2.5.4 Resources
      2.5.5 Trade Studies
   2.6 Technical Management and Control
      2.6.1 Technical Baseline Management and Control (Strategy and Approach)
      2.6.2 Technical Review Plan (Strategy and Approach)
   2.7 Integration with Other Management Control Efforts
      2.7.1 Acquisition Strategy
      2.7.2 Risk Management
      2.7.3 Integrated Master Plan
      2.7.4 Earned Value Management
      2.7.5 Contract Management
## Appendix – CMMI® Compliance Matrix

### PROJECT PLANNING

<table>
<thead>
<tr>
<th>CMMI®-SE/SW Goal/Practice Number</th>
<th>CMMI®-SE/SW Level 2 Process Area</th>
<th>SSC-C PP Process Manual Paragraph</th>
<th>593 PMP Paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Establish Estimates. Estimates of project planning parameters are established and maintained.</td>
<td>3.2</td>
<td>1.2.1</td>
</tr>
<tr>
<td>PP 1.1</td>
<td>Estimate the Scope of the Project. Establish and maintain a top-level work breakdown structure (WBS) to estimate the scope of the project.</td>
<td>3.2</td>
<td>1.2.1 3 Appendix A</td>
</tr>
<tr>
<td>PP 1.2</td>
<td>Establish Estimates of Project Attributes. Establish and document estimates of the attributes of the work products and tasks.</td>
<td>3.2</td>
<td>1.2.1 1.3</td>
</tr>
<tr>
<td>PP 1.3</td>
<td>Define Project Life Cycle. Define the project life cycle phases upon which to scope the planning effort.</td>
<td>3.2</td>
<td>1 1.2.1</td>
</tr>
<tr>
<td>PP 1.4</td>
<td>Determine estimates of Effort and Cost. Estimate the project effort and cost for the attributes of the work products and tasks based on estimation rationale.</td>
<td>3.2</td>
<td>1.3 1.2.1 Appendix A</td>
</tr>
<tr>
<td>PP 2</td>
<td>Develop a Project Plan. A project plan is established and maintained as the basis for managing the project.</td>
<td>3.3</td>
<td>1 1.2.1</td>
</tr>
</tbody>
</table>
Organizational Measurement Repository (OMR)

- Organizational database for collecting standard project measures and providing analysis
- Currently, the OMR accepts the following standard project measures

<table>
<thead>
<tr>
<th>Category</th>
<th>Core Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule Performance</td>
<td>• Estimated vs. Actual Milestone dates</td>
</tr>
<tr>
<td></td>
<td>• Estimated vs. Actual Monthly Task completions</td>
</tr>
<tr>
<td>Cost Performance</td>
<td>• Estimated vs. Actual Milestone costs</td>
</tr>
<tr>
<td></td>
<td>• Estimated vs. Actual Monthly costs</td>
</tr>
<tr>
<td>Process Performance</td>
<td>• Total # of noncompliance issues</td>
</tr>
</tbody>
</table>
OMR Structure

OMR Datastore ➔ OMR Client Application

Organizational Performance & Analysis

- Population Size: 172
- Mean: -21.22%
- Median: -6.22%
- Mode: 0.00%
- Min: -163.12%
- Max: 330.77%
- Variance: 71.85%
- Standard Deviation: 84.79%
- Probability of X < Min: 4.75%
- Probability of X > Max: 0.00%
- Probability of Min < X < Max: 95.25%

Metrics Inputs ➔ Analysis

Project Performance
• Provides interface for input and query functions
• Generates quarterly organizational report
• Projects can use to manage own projects
  – Capture standardized cost, schedule, and process performance
• OMR implementation included hands-on training
• Laying the groundwork for higher maturity
OMR Reports
Project-Level Schedule Deviation

Project Phase Schedule Deviation

- Requirements: -1.22%
- Design: -7.29%
- Implementation: 5.15%
- Unit Integration Testing: 11.29%
- System Testing: 5.62%
- Acceptance Testing: -6.25%
- Delivery: 0.00%
### Additional/Modified Measures

**To Be Implemented in OMR**

<table>
<thead>
<tr>
<th>Category</th>
<th>Core Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost Performance</strong></td>
<td>• <strong>Government vs Contractor budget</strong></td>
</tr>
<tr>
<td>(More granularity)</td>
<td>– ODC</td>
</tr>
<tr>
<td></td>
<td>– Travel</td>
</tr>
<tr>
<td></td>
<td>– Training</td>
</tr>
<tr>
<td></td>
<td>– Materials</td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>• <strong>Peer Reviews</strong></td>
</tr>
<tr>
<td></td>
<td>– Effectiveness</td>
</tr>
<tr>
<td></td>
<td>– ROI (hours expended vs hours saved)</td>
</tr>
<tr>
<td></td>
<td>• <strong>Pre-Deployment Defect Detection/Prevention</strong></td>
</tr>
<tr>
<td></td>
<td>– Defect decrease for successive phases</td>
</tr>
<tr>
<td></td>
<td>– PITCO vs SOVT defects</td>
</tr>
<tr>
<td></td>
<td>• <strong>Post-Deployment Defects</strong></td>
</tr>
</tbody>
</table>

Need improved project and organizational measures to address Maturity Level 4/5 requirements
Appraisal Wizard Tool
Used for SCAMPI Appraisals

- Designed for CMMI appraisals
- Link to project documents
- Easy to configure
- Captures team comments
- Improves efficiency of appraisal team

Appraisal Wizard is a product from Integrated Systems Diagnostics, Inc.
http://www.isd-inc.com
Training

- Training Architecture
- Courses
SE & PI Training Architecture

- **Foundation of PI and CMMI®**
  - PI WBT
  - SEI Intro to CMMI®
    - 3-day

- **Core SSC-C project and engineering processes (Level 2 and 3)**
  - Engineering Project & Process Mgmt Workshop
  - SE for Managers
  - SEMP Workshop
  - SE Fundamentals
  - Intro to Software Engineering
  - SE 101 WBT
  - Architecture Dev. WBT
  - Risk Management WBT

- **Subject Matter Experts - Use commercially available on-site classes**
  - Quality Engineering
  - Requirements Analysis
  - Risk Management

- **Prepare Projects for BSC or SCAMPI**
  - Appraisal & Assessment Workshop

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Approved for public release; distribution is unlimited (3 OCT 2007)
Intro to Process Improvement WBT

Introduction to SSC-C Process Improvement

- Courseware Operations
- Course Introduction
- Introduction to Process Improvement
- Terminology
- The CMMI® Model
- SSC-C Implementation
- Organizational Implementation
- Process Manuals
- Course Summary

Originally given as a podium course, converted to Web Based Training in 2004
Now required for all employees

Approved for public release; distribution is unlimited (3 OCT 2007)
• 3-day *Introduction to CMMI®* course teaches the full CMMI® model
  – Students learn how the best practices build and relate across process areas
  – Learn the terminology

• SEI-Authorized instructors are well-versed in our implementation to augment material with SSC-C specific content
  – Highlight SSC-C tools and resources
  – Actively involved in projects, teams, and infrastructure

• Over 350 employees trained
  – Want to build a cultural foundation within the engineering departments
3-day on-site, classroom course
- Based on SMU SE Masters course
- Customized to incorporate SSC-C SE process
- Over 340 SSC-C engineers trained

1-day SE for Managers course added
- Over 60 SSC-C managers trained

“It was extremely beneficial to have a professor with extensive knowledge of the subject matter and one who could apply it to the SPAWAR methods.”

“The most positive aspects I took from the class was the visual correlation with what was asked for and what was produced.”

“I would recommend it to all the program leads/engineers.”

Student Feedback

Began in Dec. 2004
New On-Site Courses

• **Risk Management**
  – Piloted in September, 2007
    • 4-day course
  – Designed for Risk Managers or Project Managers

• **Engineering Project & Process Mgmt Workshop**
  (aka SE Process Improvement)
  – Focus on how to use the SSC-C processes on your project
    • Using ePlan Builder to develop plans
    • How to establish your CM and PPQA procedures
  – Round 2 of curriculum review completed in September

• **Quality Assurance (FY2008)**
  – Initial discussions held with ASQ certified instructor to tailor course for Quality Managers at the project level
Web Based Training (WBT) Modules

- Developed to directly meet SSC-C’s needs
  - Embedded links directly to SSC-C documents and SOPs
  - DAU too ACAT-level/large program oriented
- WBTs feature extensive branching and rollovers
  - Better course flow and maintains interest
  - Provides more detail for those interested
- Audio summary on many pages
- Bookmark progress – come back later
- Courses developed to be NMCI and 508 compliant
  - Utilize HTML, JavaScript, and ASP pages with SQL Server database
  - Designed for Internet Explorer (5.5 +), Flash (5.0 +), Windows Media Player (9.0 +)
Introduction to Systems Engineering

- 10-module web-based training (~16 hours)
- Closely aligned to SSC-C SE Process, SE Fundamentals Course, ISO/IEC 15288 and IEEE standards
- Includes hotlinks to referenced documentation
  - Process manuals, policies, standards
  - Great for Topic-specific refresher training

Released in Jan. 2006
• **Topics**
  – Risk identification
  – Analysis tools and techniques
  – Mitigation planning
  – Risk monitoring

• **Section Test Questions**

• **Hot Links to Examples**
  – SSC-C Formats
  – Project Risk Reports
  – Tools
  – DAU / External resources

More relevant and understandable for SSC-C than the DAU module
• Introduction to Architecture Development and DoDAD
  – Designed to educate and promote value of system architecture to non-architects and new engineers
  – Tests for understanding after each section
Summary and Results
What We Have Accomplished

• **Process Focus**
  – Defined Policies and Processes
  – Aligned with DoD and SPAWAR guidance
  – Aligned with industry standards and CMMI® model
  – Built organization structured around processes and process improvement

• **Training is Critical**
  – Providing Fundamentals of Engineering for new and old professionals
  – Developed web-based training for “self-paced” and refresher training
  – Defining a structured technical career development path for engineers

• **Tools for the Engineers**
  – Developed *ePlan Builder* application to generate planning documents
  – Developed templates, checklists, and web-based document repositories to link standards and DoD guidance to day-to-day tasks and processes

**Early and persistent Systems and Software Engineering applied to programs and projects**
Lessons Learned

- Senior Management support is critical to success

- **Training**
  - Everyone needs to be engaged – “train the masses”
  - Specific training for process owners/subject matter experts

- **Utilize Teams (IPTs) as champions of specific processes**
  - Multi-department representation
  - Change agent mentality
  - Process-focused charters

- **Resource Properly**
  - Implement with projects that want to improve, can benefit from efforts, and that recognize own weaknesses
  - EPO staff provided skilled coaching, resources, support, and tools
  - Project members learned by doing and maintaining

- **Goals and Publicity**
  - Keep goals to sizable bites (projects)
  - Publicize successes; Share best practices
Is the SE Revitalization Working?

• Recognition of SE and CMMI effort
  – 1st SPAWAR Systems Center to achieve Maturity Level 2 (2005)
  – 1st SPAWAR Systems Center to achieve Maturity Level 3 (2007)
  – Multiple presenter at NDIA SE and CMMI conferences
    • High interest in Tools, Training, and Implementation
Is the SE Revitalization Working?

• Business Results
  – SCN: “They see us as a model and want to increase our efforts.”
  – Automation Program: “We had hundreds of sites and there was a need for a structured organization to put a ‘wrapper’ around that and control it. CMMI became the wrapper.”
  – CICS: “CMMI was key to achieving the project goal.”
  – VIDS: “The VIDS failure (2000) motivated implementing CMMI because the team needed to change course or the customer would have no confidence in system development. It was a tremendous success…”

• Others Asking for Help
  – PMS 408 – CREW program
  – SESG / NAVAIR / NAVSEA
  – Marine Corp – Quantico
  – Air Armament Center, Eglin AFB
• Increase usage of tools across departments/projects
• Add additional plans to ePlan Builder as needed
• Continue internal CMMI Level 3 mini assessments
• Enhance/Expand OMR
• Command and Department Project Reviews process
  – Look at quality of plans and implementation of best practices
  – Reviews of project status by management driven by project metrics
  – More Peer Reviews to measure “saves”
• Better tailoring guidance for smaller projects

Begin Maturity Level 4/5 implementation
Any Questions?

Contact Information:

Michael T. Kutch, Jr.
SPAWAR Systems Center Charleston
Email: michael.kutch@navy.mil
Phone: 843-218-5706

Mike Knox
TECHSOFT, Inc.
Email: mjknock@techsoft.com
Phone: 850-469-0086