Systems Engineering Self Assessment of an Air Force Acquisition Unit

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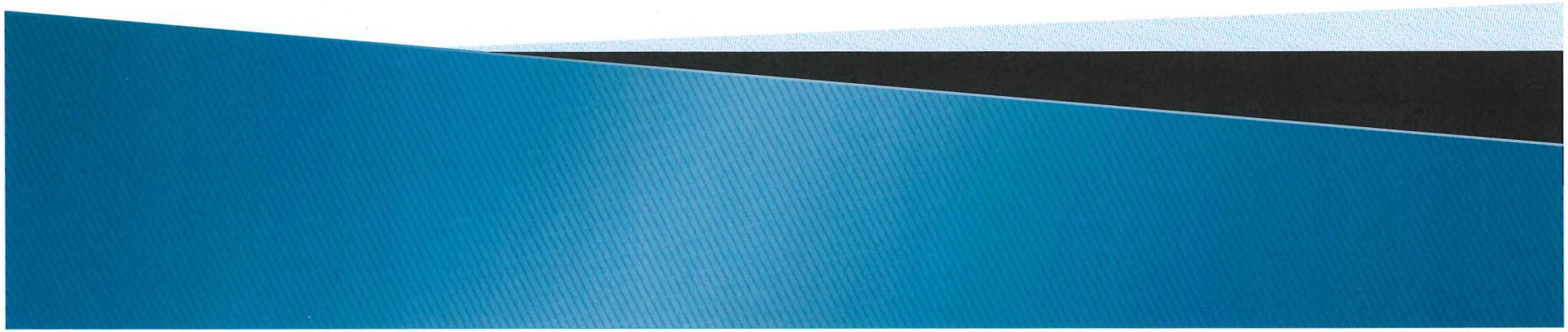
09 Sep 09



Agenda

- Project Overview
- AF SEAM Background and Goals
- AF SEAM Practices
- Project Approach
- Self Assessment Results
- AF SEAM Cost/Benefit Analysis
- AF SEAM Weaknesses
- SE Findings and Problems
- Problem Evaluation
- Major SE Problems
- Suggested Action Plan
- Other Considerations
- SE Improvement Roadmap

Conducting the SE Self Assessment

Analyzing the SE Self Assessment data

Project Overview

- Systems Engineering (SE) Self Assessment of an Air Force major systems acquisition unit
- Used the Air Force Systems Engineering Assessment Model (AF SEAM)
  - 10 SE Process Areas
  - 190 best practices
- Identified 120 key findings
  - Findings grouped into 20 problems
  - Top 3 problems are analyzed in detail

AF SEAM Background

- In 2006, AFMC Engineering Council Action Item to:
  - Provide an AF-wide SE Assessment Model
  - Involve AF Centers (product and logistics)
  - Leverage current CMMI®-based models in use at AF Centers
  - Baseline Process capability & usage
- Definition of Air Force Systems Engineering Assessment Model (AF SEAM)
  - A single AF-wide tool which can be used for the assessment and improvement of systems engineering processes in a program/project.

AF SEAM Goals

- Ensure a Consistent Understanding of SE
- Ensure Core SE Processes are in Place and Being Practiced
- Document repeatable SE "Best Practices" across AF
- Identify Opportunities for Continuous Improvement
- Clarify Roles and Responsibilities
- Improve Program Performance & Reduce Technical Risk

AF SEAM Practices

SE Process Area	Specific Practices (SPs)	General Practices (GPs)	Total SE Practices
Configuration Mgmt	8	7	15
Decision Analysis	5	7	12
Design	14	7	21
Manufacturing	12	7	19
Project Planning	15	7	22
Requirements	13	7	20
Risk Mgmt	7	7	14
Sustainment	15	7	22
Technical Mgmt and Control	15	7	22
Verification and Validation	16	7	23
Total	*120*	*70*	*190*

AF SEAM General Practices

- GP1 – Description of the Process Area
- GP2 – Plans
- GP3 – Resources
- GP4 – Roles & Responsibilities
- GP5 – Training
- GP6 – Monitoring & Controlling
- GP7 – Management Visibility

Sample Specific Practice

- RMG1P1 Determine risk sources and categories
- Description: Establish categories of risks and risk sources for the project initially and refine the risk structure over time (e.g., schedule, cost, supplier execution, technology readiness, manufacturing readiness, product safety, and issues outside control of team), using Integrated Product Teams. Quantify the risk probability and consequence in terms of cost and schedule.
- Typical Work Products:
  - Risk matrix
  - Risk management plan
- Reference Material: DoD Risk Management Guide, AFI 90-901
- Other Considerations: Consider using Acquisition Center of Excellence Risk Management Workshops when needed. For manufacturing risks consider the capability of planned production processes to meet anticipated design tolerances. Include the supplier's capacity and capabilities in the analysis.

Project Approach

- Team assembled and trained on the AF SEAM
- Initial evaluation Specific Practices (SPs)
  - Interviewees for each SP identified
  - Questions grouped by interviewee to save time
- Interviews conducted 9-27 Feb 09
  - Wide range of expertise and seniority
  - Yes or no answers
  - Practices performed at less than a 90% were a "no"
- Team evaluated the interview results
  - Subject Matter Expert (SME) answers weighted more
  - Specific answers weighed more than general ones

Specific Practices Results

Process Area		SP Score
Configuration Mgmt	CM	100%
Decision Analysis	DA	40%
Design	D	43%
Manufacturing	MG	90%
Project Planning	PP	33%
Requirements	R	31%
Risk Mgmt	RM	29%
Sustainment	S	93%
Technical Mgmt and Control	TMC	60%
Verification and Validation	V	50%

80 to 100%
60 to 79%
0 to 59%

General Practices Results

	CM	DA	D	MG	PP	R	RM	S	TMC	V	
Description											60%
Plans											40%
Resources											20%
Roles & Responsibilities											40%
Training											20%
Monitor & Control											20%
Mgmt Visibility											80%
	71%	43%	43%	71%	29%	14%	29%	86%	14%	0%	

Overall Results

Process Area		Avg of SP & GP
Configuration Mgmt	CM	86%
Decision Analysis	DA	41%
Design	D	43%
Manufacturing	MG	81%
Project Planning	PP	31%
Requirements	R	23%
Risk Mgmt	RM	29%
Sustainment	S	90%
Technical Mgmt and Control	TMC	37%
Verification and Validation	V	25%

AF SEAM Cost/Benefit Analysis

- Cost: roughly 560 hours
  - At about$60 an hour, this is $33,600
  - Opportunity cost, not actual cost
  - Negligible material or software costs
- Benefits
  - Identifies SE strengths and weaknesses
    - Failed 7 of 10 SE Process Areas
    - General Practices are good report cards
  - Provides a framework for SE in an Air Force acquisition environment

AF SEAM Weaknesses

- Highly subjective
  - 90% confidence level is a judgment call
  - Most of the time experts disagreed
- Answers vary by interviewee perspective
  - Optimism/Pessimism varies wildly
  - Specialists only answered regarding their specialty
- Many practices depend on the Contractor
  - Often answers were proxies for Contractor's actions
  - AF SEAM focuses on Air Force, but most of the real work is performed by the contractor
  - Future versions should further address working relationship between government and contractor

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Conducting the SE Self Assessment

Analyzing the SE Self Assessment data

SE Findings and Problems

- Thorough analysis of AF SEAM interviews uncovered 120 key findings
- These findings can be mapped to 20 over-arching SE problems
- Some findings relate to multiple problems
- 144 total mappings

Problems	Problem Descriptions	Count of Findings
B	Lack of Resources	19
J	Missing Plans	14
A	Insufficient Training	13
H	Poor Monitoring	12
C	Unclear Roles and Responsibilities	12
D	Poor Interface Control	10
E	Shelf-ware (plans that are not used)	9
G	Poor Metrics	9
O	Poor Execution of Plans	8
L	Lack of Requirements Traceability	8
N	Inadequate Communication	7
K	Poor Documentation	6
P	Requirements Creep	4
I	Lack of Management Visibility	3
M	Technical Reviews Passed Prematurely	3
Q	Over Reliance on the Contractor	3
F	Poor Estimating	2
R	Cumbersome Bureaucratic Processes	2
T	Inappropriate Design Process	1
S	Lack of Reliability	1

Problem Evaluation

- Each Problem was evaluated using 3 criteria
  - Solution Feasibility
  - Potential Gain
  - Number of Findings
- Surveys sent to SMEs and unit leadership
  - Asked to rank each problem from 1 to 10 for Solution Feasibility and Potential Gain
  - The surveys generated average scores
- Importance = Square Root of (Mean Feasibility * Mean Gain + Number of Findings)

Survey Results: Solution Feasibility

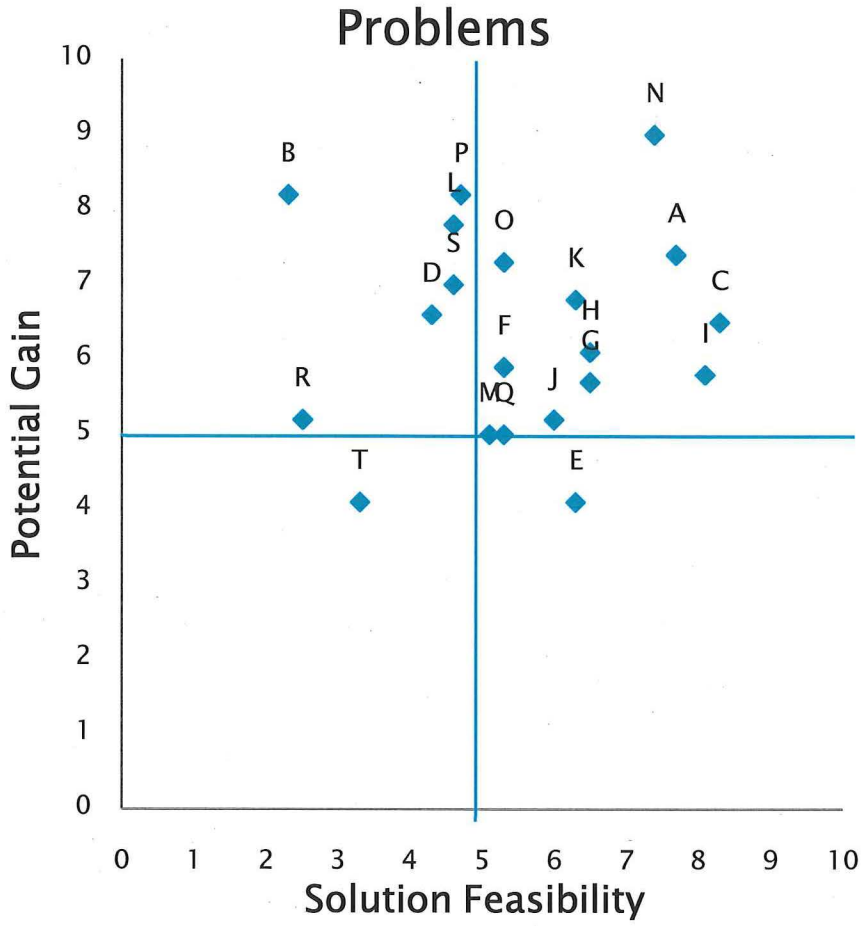
		Commander	Deputy Commander	Deputy Director	Technical Director	Squadron Commander	Engineering Chief	Project Officer	SE Project Officer	Contracts Rep	FFRDC Engineer	Average
Problem Descriptions	**Count of Findings**	**Solution Feasibility**	**Solution Feasibility**	**Solution Feasibility**	**Solution Feasibility**	**Solution Feasibility**	**Solution Feasibility**	**Solution Feasibility**	**Solution Feasibility**	**Solution Feasibility**	**Solution Feasibility**	**Solution Feasibility**
Lack of Resources	19	3	7	2	1	1	3	1	1	1	3	**2.3**
Missing Plans	14	4	7	9	5	4	6	5	4	7	9	**6.0**
Insufficient Training	13	3	8	9	10	7	8	7	8	8	9	**7.7**
Poor Monitoring	12	7	7	9	8	3	6	9	3	3	10	**6.5**
Unclear Roles and Responsibilities	12	8	8	10	8	5	8	9	9	9	9	**8.3**
Poor Interface Control	10	7	8	5	2	7	4	2	2	2	4	**4.3**
Shelf-ware (plans that are not used)	9	2	9	9	8	7	6	3	3	8	8	**6.3**
Poor Metrics	9	9	6	8	10	8	6	7	4	4	3	**6.5**
Poor Execution of Plans	8	4	5	8	10	5	4	6	5	2	4	**5.3**
Lack of Requirements Traceability	8	4	6	7	1	7	3	2	6	8	2	**4.6**
Inadequate Communication	7	5	5	10	9	8	4	9	10	5	9	**7.4**
Poor Documentation	6	3	10	10	7	5	7	4	5	6	6	**6.3**
Requirements Creep	4	9	6	6	3	7	4	2	6	2	2	**4.7**
Lack of Management Visibility	3	6	9	6	5	9	8	10	10	8	10	**8.1**
Technical Reviews Passed Prematurely	3	10	1	7	5	8	7	2	8	1	2	**5.1**
Over Reliance on the Contractor	3	8	6	2	9	2	4	3	9	2	8	**5.3**
Poor Estimating	2	4	8	2	8	2	3	8	7	4	7	**5.3**
Cumbersome Bureaucratic Processes	2	2	2	2	2	2	1	10	1	2	1	**2.5**
Inappropriate Design Process	1	5	5	4	6	8	2	3	7	3	3	**4.6**
Lack of Reliability	1	1	4	7	8	3	4	1	2	1	2	**3.3**
		5.2	6.4	6.6	6.3	5.4	4.9	5.2	5.5	4.3	5.6	5.5

Survey Results: Potential Gain

Problem Descriptions	Count of Findings	Commander Potential Gain	Deputy Commander Potential Gain	Deputy Director Potential Gain	Technical Director Potential Gain	Squadron Commander Potential Gain	Engineering Chief Potential Gain	Project Officer Potential Gain	SE Project Officer Potential Gain	Contracts Rep Potential Gain	FFRDC Engineer Potential Gain	Average Potential Gain
Lack of Resources	19	9	10	9	8	3	8	10	8	10	7	**8.2**
Missing Plans	14	8	7	5	4	7	7	5	1	3	5	**5.2**
Insufficient Training	13	10	7	5	9	5	7	7	10	8	6	**7.4**
Poor Monitoring	12	5	6	7	4	5	6	8	7	8	5	**6.1**
Unclear Roles and Responsibilities	12	10	7	7	5	5	7	4	6	7	7	**6.5**
Poor Interface Control	10	9	9	4	9	6	2	3	5	10	9	**6.6**
Shelf-ware (plans that are not used)	9	4	6	1	3	4	7	6	2	5	3	**4.1**
Poor Metrics	9	7	6	3	5	8	6	7	3	6	6	**5.7**
Poor Execution of Plans	8	8	7	7	7	7	7	4	7	10	9	**7.3**
Lack of Requirements Traceability	8	9	9	7	9	9	7	5	9	4	10	**7.8**
Inadequate Communication	7	10	8	10	10	9	8	8	10	8	9	**9.0**
Poor Documentation	6	9	6	7	9	3	5	7	9	6	7	**6.8**
Requirements Creep	4	10	10	7	9	8	8	4	8	10	8	**8.2**
Lack of Management Visibility	3	10	7	8	5	2	5	6	6	6	3	**5.8**
Technical Reviews Passed Prematurely	3	7	1	5	5	3	8	2	5	7	7	**5.0**
Over Reliance on the Contractor	3	3	6	5	2	8	6	10	2	5	3	**5.0**
Poor Estimating	2	8	6	7	3	2	3	8	4	8	10	**5.9**
Cumbersome Bureaucratic Processes	2	8	5	7	3	7	8	2	1	3	8	**5.2**
Inappropriate Design Process	1	10	7	7	8	2	10	5	4	8	9	**7.0**
Lack of Reliability	1	1	5	6	2	2	2	10	3	3	7	**4.1**
		7.8	6.8	6.2	6.0	5.3	6.4	6.1	5.5	6.8	6.9	6.3

Potential Gain vs. Feasibility

Problems	Problem Descriptions	Solution Feasibility	Potential Gain
B	Lack of Resources	2.3	8.2
J	Missing Plans	6.0	5.2
A	Insufficient Training	7.7	7.4
H	Poor Monitoring	6.5	6.1
C	Unclear Roles and Responsibilities	8.3	6.5
D	Poor Interface Control	4.3	6.6
E	Shelf-ware (plans that are not used)	6.3	4.1
G	Poor Metrics	6.5	5.7
O	Poor Execution of Plans	5.3	7.3
L	Lack of Requirements Traceability	4.6	7.8
N	Inadequate Communication	7.4	9.0
K	Poor Documentation	6.3	6.8
P	Requirements Creep	4.7	8.2
I	Lack of Management Visibility	8.1	5.8
M	Technical Reviews Passed Prematurely	5.1	5.0
Q	Over Reliance on the Contractor	5.3	5.0
F	Poor Estimating	5.3	5.9
R	Cumbersome Bureaucratic Processes	2.5	5.2
T	Inappropriate Design Process	4.6	7.0
S	Lack of Reliability	3.3	4.1

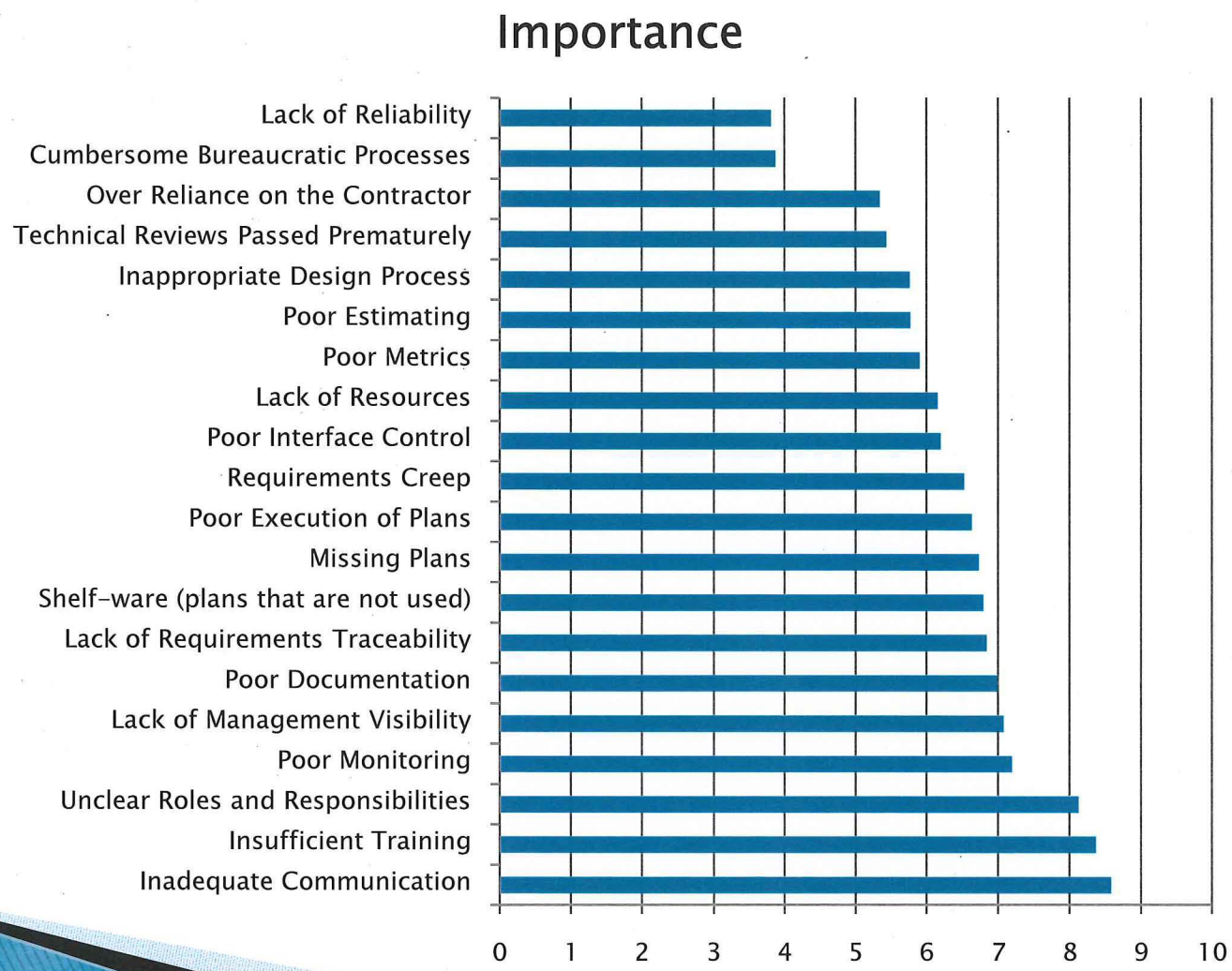


Evaluation Survey Results

Problems	Problem Descriptions	Solution Feasibility	Potential Gain	Count of Findings	Importance
N	Inadequate Communication	7.4	9.0	7	8.58
A	Insufficient Training	7.7	7.4	13	8.37
C	Unclear Roles and Responsibilities	8.3	6.5	12	8.12
H	Poor Monitoring	6.5	6.1	12	7.19
I	Lack of Management Visibility	8.1	5.8	3	7.07
K	Poor Documentation	6.3	6.8	6	6.99
L	Lack of Requirements Traceability	5.3	7.3	8	6.83
E	Shelf-ware (plans that are not used)	6.5	5.7	9	6.79
J	Missing Plans	6.0	5.2	14	6.72
O	Poor Execution of Plans	4.6	7.8	8	6.62
P	Requirements Creep	4.7	8.2	4	6.52
D	Poor Interface Control	4.3	6.6	10	6.20
B	Lack of Resources	2.3	8.2	19	6.15
G	Poor Metrics	6.3	4.1	9	5.90
F	Poor Estimating	5.3	5.9	2	5.77
T	Inappropriate Design Process	4.6	7.0	1	5.76
M	Technical Reviews Passed Prematurely	5.3	5.0	3	5.43
Q	Over Reliance on the Contractor	5.1	5.0	3	5.34
R	Cumbersome Bureaucratic Processes	2.5	5.2	2	3.87
S	Lack of Reliability	3.3	4.1	1	3.81

Importance = Square root of (Feasibility X Potential Impact + Count of Problems)

Problem Evaluation Results



Problem Evaluation Results

1. Most important (8.58 - 8.12)
   - Inadequate Communication, Insufficient Training, Unclear Roles and Responsibilities
2. Moderately important (7.19 - 6.15)
   - Poor Monitoring, Lack of Mgmt Visibility, Poor Documentation, Lack of Req. Traceability, Shelf-ware, Missing Plans, Poor Execution of Plans, Req. Creep, Poor Interface Control, Lack of Resources
3. Less Important (5.90 - 5.34)
   - Poor Metrics, Poor Estimating, Inappropriate Design Process, Technical Reviews Passed Prematurely, Over-reliance on the Contractor
4. Least important (3.87 - 3.81)
   - Cumbersome Bureaucratic Processes, Lack of Reliability

Major SE Problems: Inadequate Communication

- Communication with the contractor
  - Need to improve understanding of contractual req's
    - Frequent disputes regarding what is/is not on contract
    - Previous history of unofficial constructive changes
      - Caused cost over-runs
      - Baseline was constantly shifting
    - Contractor now using Baseline Change Mgmt System
  - Communication within the contractor is an issue
    - Engineers on different projects don't communicate as much as they should
    - How does the government deal with stove-pipes within the contractor's organization?
    - What about sub-contractors?
    - Ultimately, it is in the government's best interest to encourage dialogue and sharing where needed

Major SE Problems: Inadequate Communication

- Communication with users
  - Software project developed Configuration Management Review Board – bypassing key users
  - Use global Configuration Control Board (CCB) for all projects
- Communication across functional divisions
  - Engineering division is too stove-piped
  - Recommend: 4 people matrixed into the squadron
    - Configuration Mgmt
    - Information Assurance
    - Requirements
    - Test and Evaluation

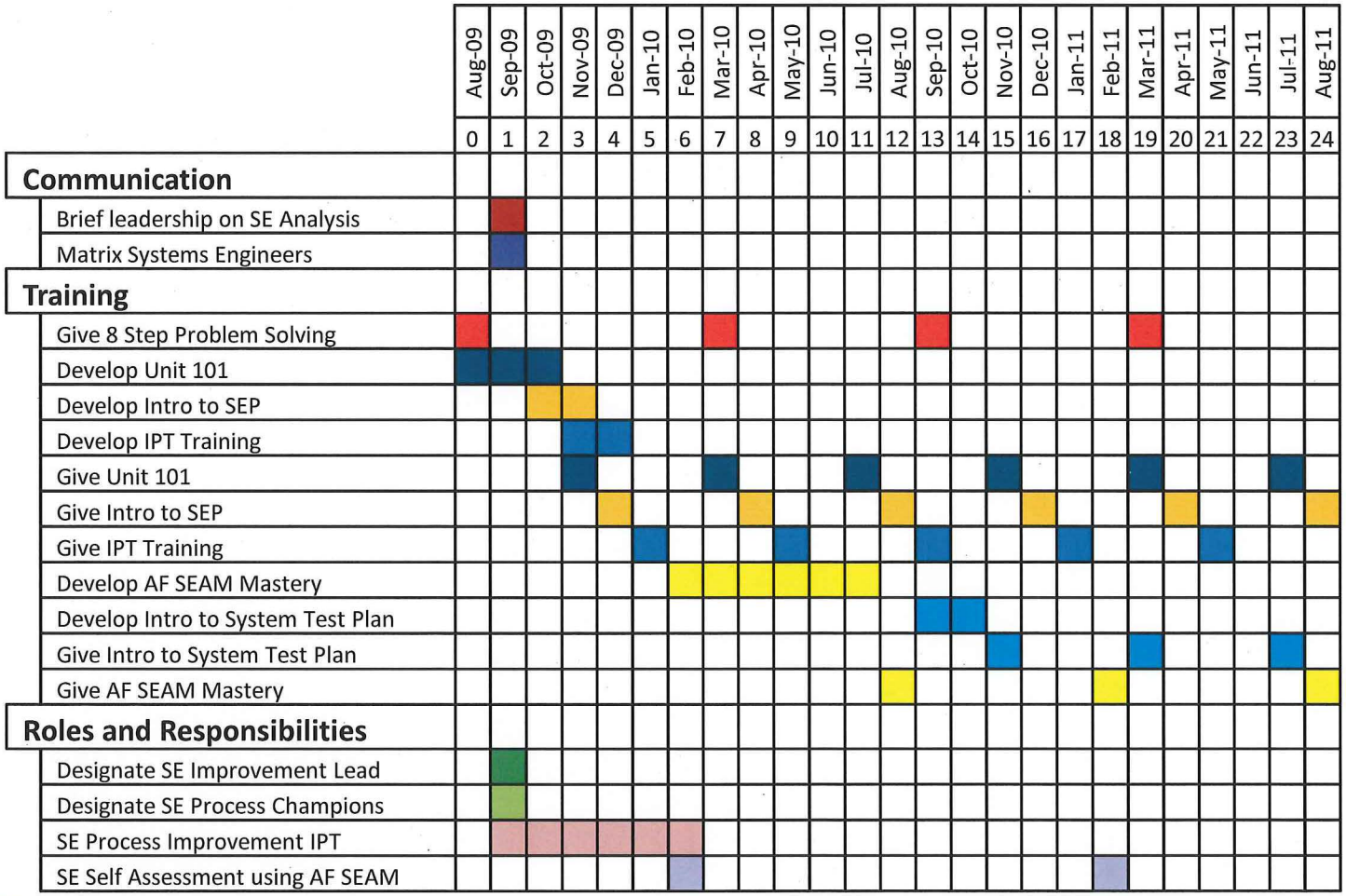
Major SE Problems: Insufficient Training

- Unit 101
  - Bring newcomers up to speed – quick changeover!
- IPT Training
  - Improve meetings and emphasize multiple disciplines
- 8 Step Problem Solving Method
  - Framework for thorough Decision Analysis
- Intro to SEP and Intro to System Test Plan
  - Short briefings to internalize these key documents
- AF SEAM Mastery
  - AF SEAM as a detailed and standardized SE teaching tool
- SE Certificate and Masters programs
  - Encourage the pursuit of relevant higher education

Major SE Problems: Unclear Roles and Responsibilities

- Assign SE Process Champions
  - Focal point for each SE Process Area
  - Every key practice now has a belly button
- Appoint a SE Process Improvement Lead
- Establish a SE Process Improvement IPT
  - Members: SE Improvement Lead and Process Champions
  - Short term goal: Passing marks on the next SE Self Assessment in February 2010
  - Long term goal: Institutionalize SE process improvements

Suggested Action Plan



Other Considerations

- Organizational Buy-in
  - Unit Commander choose which suggested actions are implemented
  - All major stakeholders were included in SE Problem Evaluation surveys
- AF SEAM and the Contractor
  - Many practices reflect the contactor's performance
  - Contractors should use the AF SEAM on themselves
- AF SEAM and Source Selection
  - AF SEAM is a standardized way of analyzing SE
  - Could be used as an evaluation criterion
  - Could use 3rd party auditors for large competitions

SE Improvement Roadmap

- Engineering Stove-piped
- No real training for most SE Process Areas
- Newcomers must learn unit basics on the fly
- No Point of Contact for most SE Process Areas
- SE resources spent in constant firefighting mode

Current State ("As Is")

- SE roles matrixed into Development Squadron
- Intensive SE training developed in house and tailored to unit
- Unit 101 for newcomers
- SE Process Area Champions
- SE Process Improvement Lead implements and institutionalizes SE best practices

Future State ("To Be")