Air Armament Center

War-Winning Capabilities…On Time, On Cost

U.S. AIR FORCE

Lessons Learned Doing Systems Engineering Assessments on the Government

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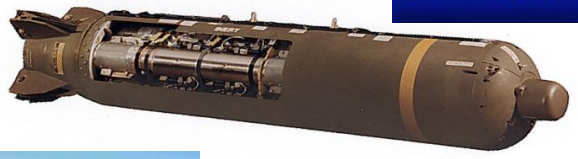
https://afkm.wpafb.af.mil/EglinSE

Product Portfolio

AMRAAM

SFW



Outline

- **Air Armament Center Systems Engineering Assessments**
  - **Why**
  - **How**
  - **What we Learned**
  - **Futures**

Today is a Discussion not a Lecture – Please Stop me Anytime!

Direction & Goals

- In 2006, EN Tasked to:
  - Perform a Center-wide SE Assessment
  - Found Out Where We Are?
  - Baseline Enterprise Process Improvement

Must Have a Champion!

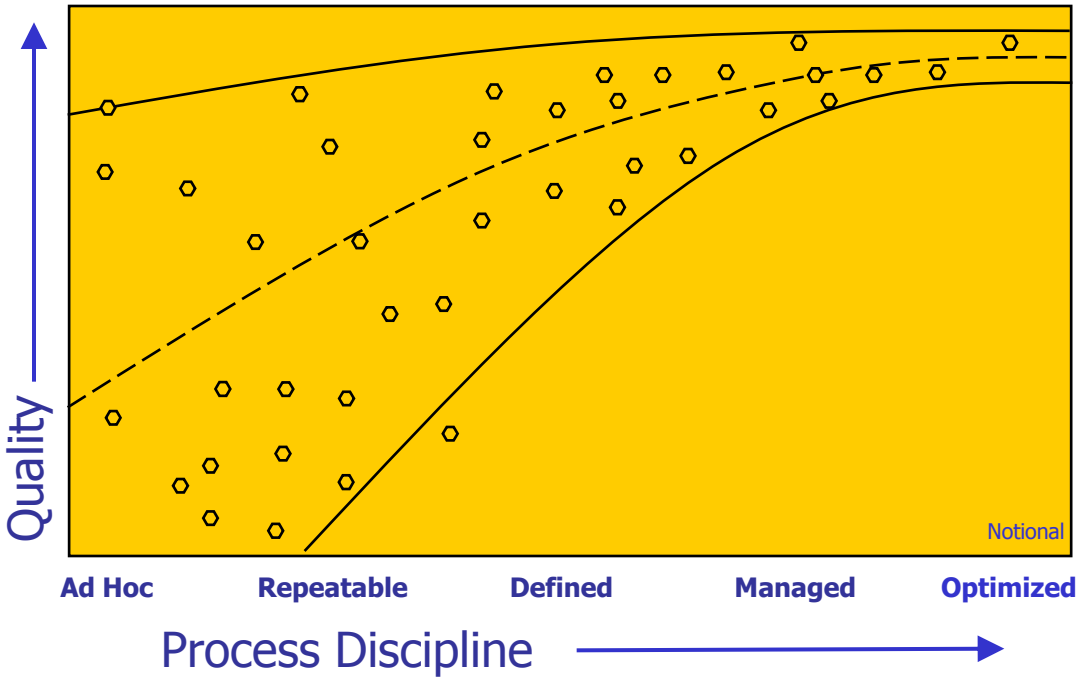
- Goals
  - Improve Program Performance & Reduce Technical Risk
  - Ensure a Consistent Understanding of SE
  - Ensure Core SE Processes are in Place and Being Practiced
    - Identify Opportunities for Continuous Improvement
    - Clarify Roles and Responsibilities
  - Institutionalize “Best Practices”

Our Approach

- **Define Systems Engineering Best Practices**
- **Benchmark Systems Engineering Implementation**
- **Establish a Baseline for Continuous Improvement**
  - **Begin Changing the Culture to Kaizen**
- **Phased Approach – 3 Phases**

Focus on Process

- **The Quality of a System or Product is Highly Influenced by the Quality of the Process Used to Develop and Maintain It**



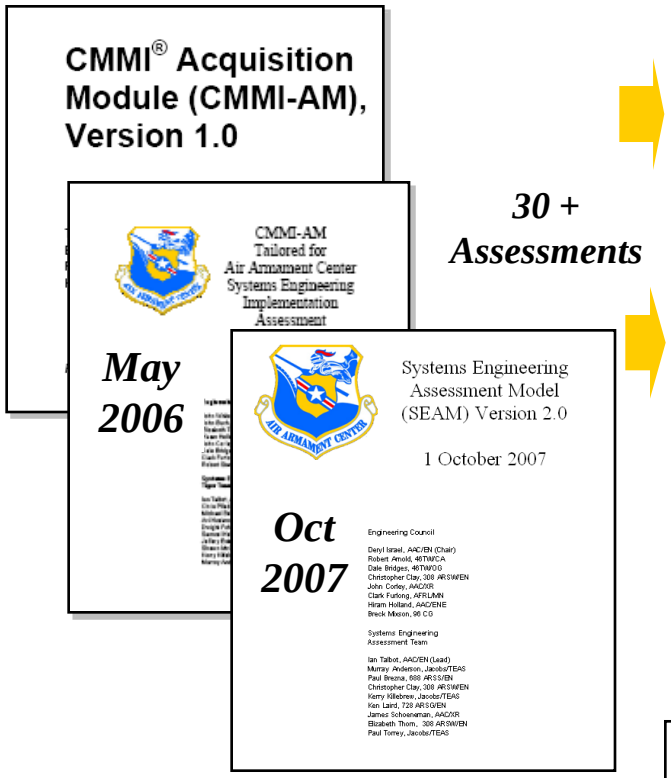
CMMI Performance Results Summary		
	Median Improvement	Number of Data Points
Cost	34%	29
Schedule	50%	22
Productivity	61%	20
Quality	48%	34
Customer Satisfaction	14%	7
ROI	4.0 : 1	22

CMU/SEI-2006-TR-004

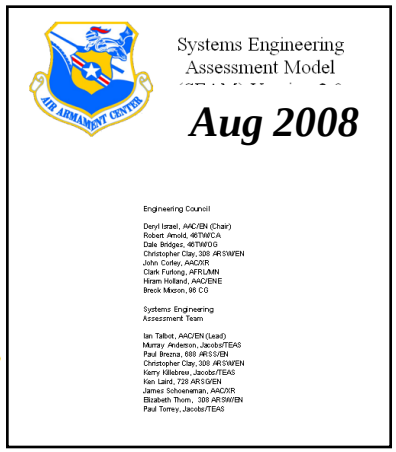
- **Process Discipline Leads to:**
  - **Predictable Program Performance**
  - **Ability to Deliver on our Commitments**

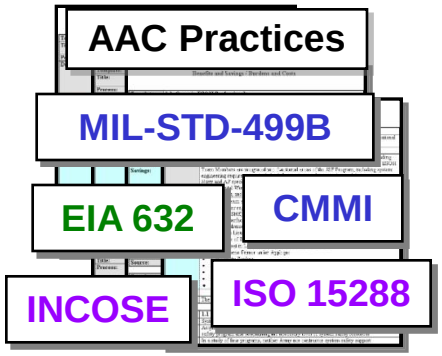
Institutionalized Process Driven SE » Lower Risk Technical Programs

AAC SEA Model Development



30 + Assessments





Systems Engineering Assessment Model v2.4

- 10 Process Areas
- 33 Specific Goals
- 115 Practices
- 7 Generic Practices
- 67 Qualifying Questions
- 47 Pages

Streamlined CMMI

Compliant with AF-SEAM v1.0

Industry/Academia
- SEI, NDIA, Boeing, Raytheon, etc.
- USC, AFIT, etc.

OSD Guidance
- DAG
- SEP Guidance

AF Guidance
- AFI 63-1201
- AFPD OSS&E

AFMC Guidance
- AFMCI 63-1201
- OSS&E

Other Centers
- ESC
- SMC

AAC Assessment Model Based on International, Industry and DoD Best Practices

Current Process Areas

- Technical Process Areas
  - Requirements
  - Design
  - Manufacturing
  - Verification & Validation
  - Fielding & Sustainment
- Project Process Areas
  - Project Planning
  - Risk Management
  - Configuration Management
  - Decision Analysis
  - Technical Assessment

- Introduction
- Goal
  - Practices
  - Grey Matter
  - Question(s)
- Goal…
  - Generic Practices
- Question(s)

AAC-SEAM v2.4

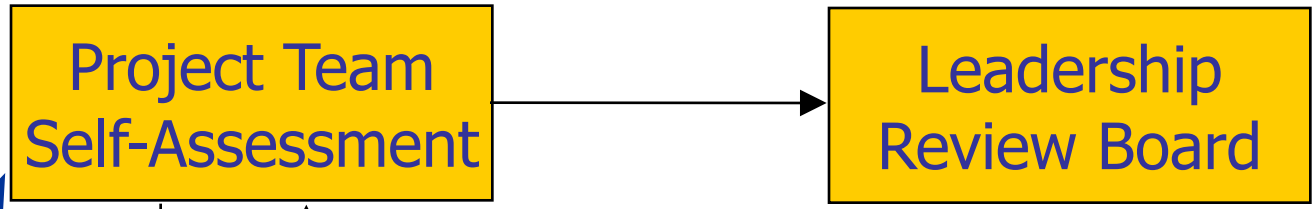
Criteria for Methodology

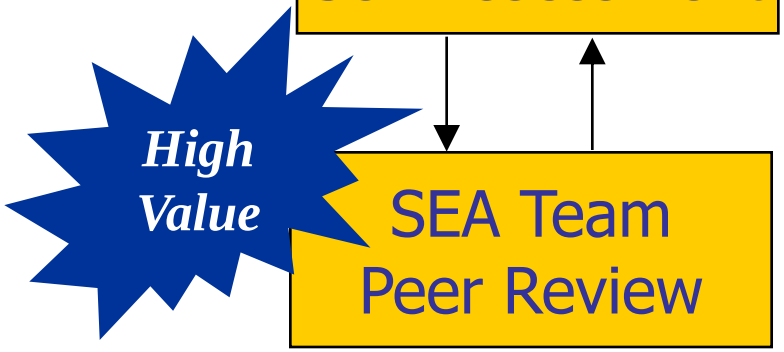
- Objective Assessment
- Provide insight into Government, Prime Contractors and Subs Process & Capability
- Facilitate Self Assessment & Continuous Improvement
  - Lean & Six Sigma
- Consistent Near and Far Term Approach

- Provide Results that are meaningful for leadership
  - Relevant to PM/PEO
  - Simple
  - Understandable
  - Graphical
- Support Multi-level Measurement & Reporting
  - Program, Group, Wing, Enterprise

SEA Methodology

Acquirer & Supplier





Co-chaired by Chief of Systems Engineering and Line Engineering Functional

Team Chaired by Senior Systems Engineer
Members from Across Multiple Programs

Assessment Process Time Required
- Leadership – 8 person hrs
- Project Team –60-100 person hrs
- SEA Team – <50 person hrs

SEA Assess What Practices are Implemented NOT How Well Executed
Future: Begin to Shift Focus to "How To" and Quality of SE Implementation

Products Provided to Program

- Training & Self Assessment
- Peer Review Collaboration & Feedback
- Validated Assessment
- Summary Memorandum
  - Findings & SE Improvement Recommendations

Benchmarking the Enterprise

Process Area Criteria*
- **>90% of Practices**
- **65-89% of Practices**
- **<65% of Practices**

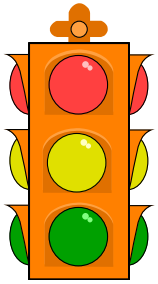
Program Criteria
- **>90% of Practices, No Red**
- **65-89% of Practices, NTE 1 Red**
- **<65% of Practices, 2 or More Red**

* Weighting

SPs75%
GPs 25%

Key Process Areas

as of 8 Jan 07	R	D	V	T	P	TA	RM	CM	DA	Pgm
Program #1										
Program #2										
Program #3										
Program #4										
Program #5										
Program #6										
Program #7										
Program #8										
Program #9										
Program #10										
Program #11										
Program #12										
Program #13										
Program #14										
Program #15										
Program #16										
Program #17										
Program #18										
Center Average										



Portfolio Criteria
- **95% Programs Green**
- **75%-95% Programs Green, <10% Programs Red**
- **<75% Programs Green or >10% Programs Red**

PEO Set High Bar!

Lessons Learned

- **Personnel Resources are Stretched and Need SE Training & Experience**
- **Process and Procedures are Needed to Ensure More Repeatable/Consistent Application of SE**
- **Product Line Specific Guidebook Capturing Eglin Experience in Weapons Desired**

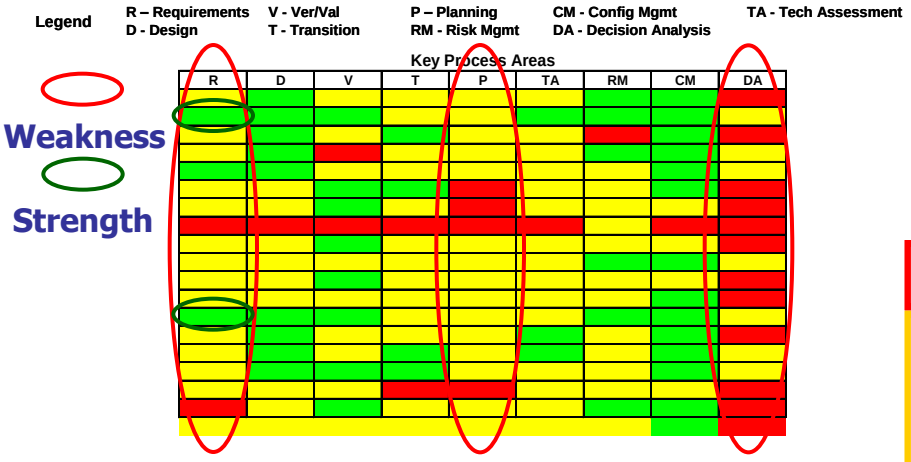
The Good

- **Requirements Control & Verification Working Group**
- **Iterative Requirements & Design Trade-off Working Group**
- Concurrent Engineering to Ensure Successful Transition to Production
- Contract Incentives for Reducing Cost and Increasing Reliability
- Full Trust Integrated Teaming
- **Integrated & Overarching Risk Management Strategy**

"Following MIL-STDs was Better than Having No Process at All"

Spiral 1

The Bad



Systemic Analysis

Decision Analysis	RED
Planning	YELLOW
Requirements	
Risk Management	
Verification & Validation	
Transition	
Technical Assessment	
Design	
Configuration Management	GREEN

Better

- Areas that Need Work
  - Requirements
  - Decision Analysis
  - Planning
  - Process Integration Particularly Risk Management
- Model Expansion Needed
  - Manufacturing (Transition to Production)
  - Sustainment

Added in Version 2.0

Requirements Weaknesses

- **Design Mission Reference Profiles (RG1P2)**
  - **Comprehensive Definition of Product Characteristics in Engineering Terms and Documentation of the Interaction of the Product with the Environment, Other Systems, and Operational Users [Willoughby].**

    Do we understand the edges of the technical performance envelope?

- **Validate Requirements (RG2P3)**
  - **Ensure the Evolving Product will Perform as Intended in the Operational Environment [CMMI].**

    Do the derived requirements accurately and completely represent what is needed? and no more… How were they validated?

Reference: AAC SEAM v2.4

Some Solutions

- **Develop Valid Mission Reference Profiles to Support Design**
  - **Validate Concepts of Employment**
  - **Obtain Accredited Simulation Capability Including Carriage, Separation, Fly-out**
    - **Engage Independent Subject Matter Experts**
    - **Discover & Examine Stressing Conditions**
  - **Anchor the Models with Data**
    - **Test Prototypes in Wind Tunnel**
    - **Test Instrumented Flight Vehicles in Carriage, Separation and Fly-out Modes**
- **Test Sample Conditions of All Configurations With Representative Hardware Early and Allow Schedule for Issue Resolution**

Evaluate All Load-Out Conditions

Vibration

Acoustics

Temperature

Electromagnetic

Aerodynamic

Sustainment Weaknesses

- **Establish Operational, Suitability and Effectiveness Baselines (SG4P1)**
  - **Conduct Health Monitoring and Verification to Ensure Fielded Product Matches Baseline Performance [AFMCI]**

    How do we assure the products continued safety & performance?

- **Perform Audits to Maintain Integrity (CMG3P2)**
  - **Ensure Processes for Maintaining the Integrity of the Fielded Configuration are Effective [CMMI].**

    How do you know if Time Critical Technical Orders are compete?

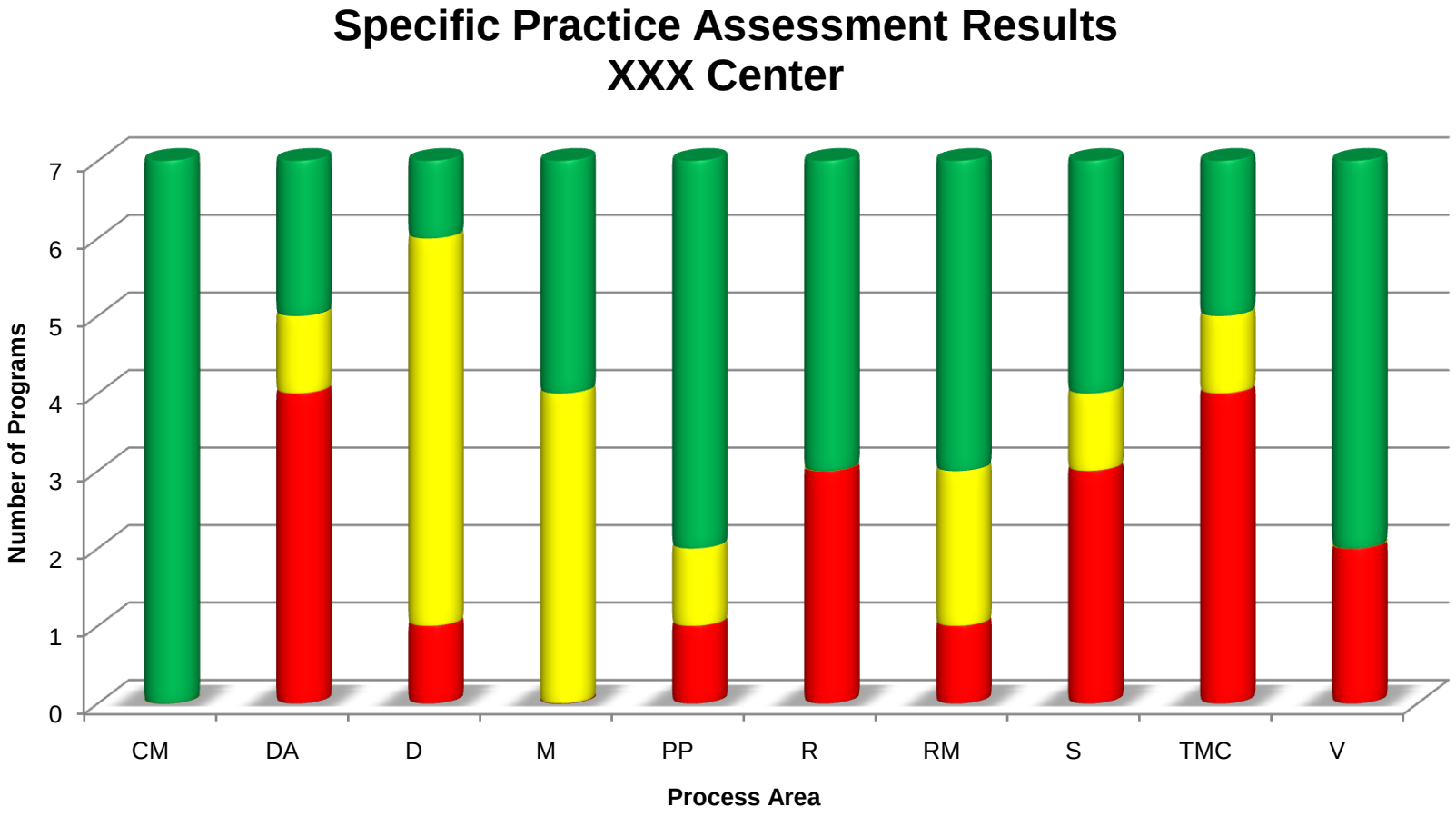
Reference: AAC SEAM v2.4

AF-SEAM Background

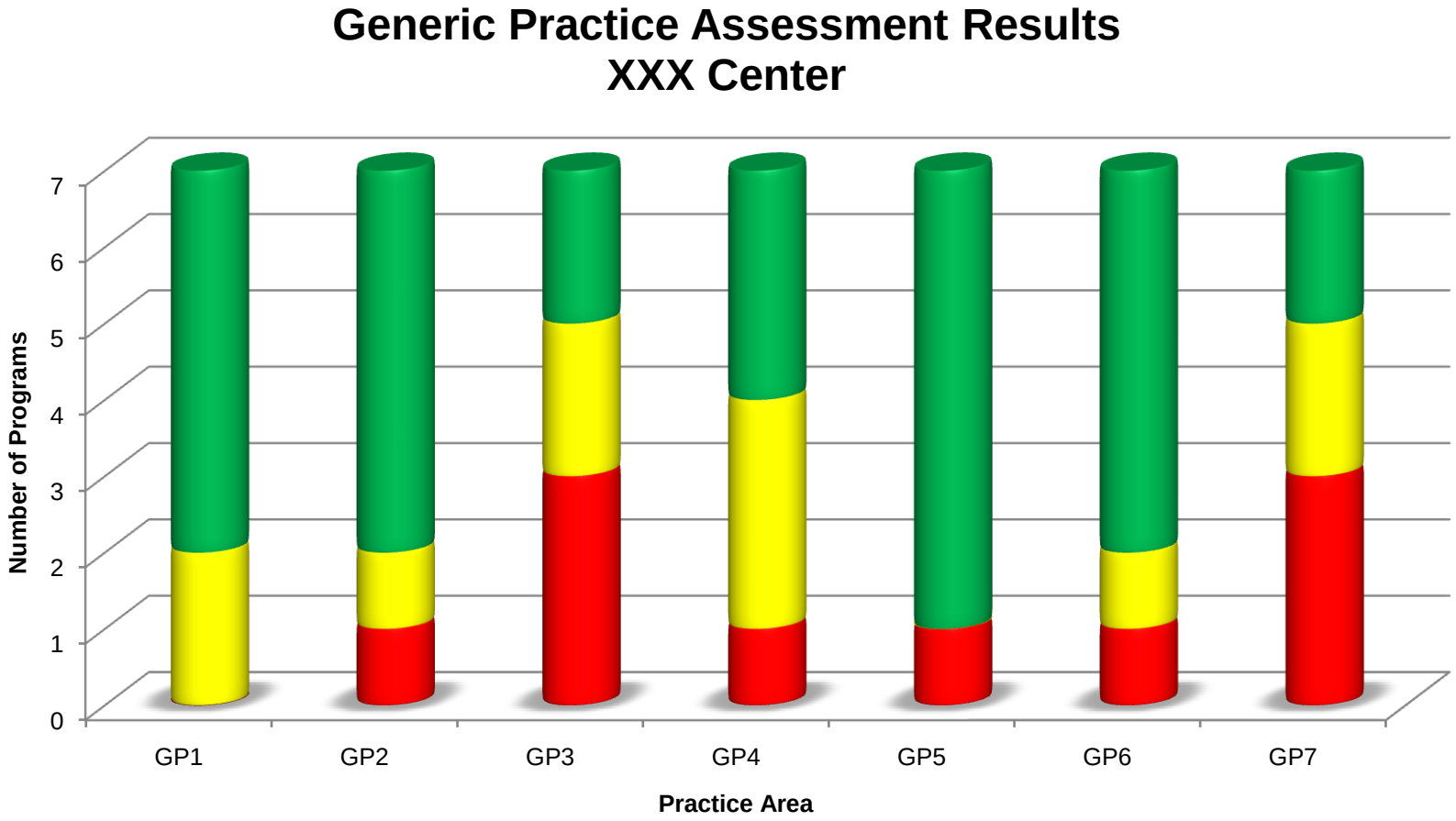
- **In 2006, USAF Material Command Engineering Council Action Item to:**
  - **Provide an USAF-wide SE Assessment Model**
  - **Involve USAF Centers (product and logistics)**
  - **Leverage current CMMI®-based models in use at AF Centers**
  - **Baseline Process Capability & Usage**
- **AF Systems Engineering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

Version 1.0 Completed August 2008

AF-SEAM SP Roll-Up



AF-SEAM GP Roll-Up



Future Concept

Key Process Area: Manufacturing or TMC

Goal: – Product and process quality is assessed and improved.

Notional

Practice:

P1 Establish and maintain a quality management system.

- *5: The developer and major suppliers have an ISO 9000/AS9100 certified operation with recent AS9101 audit at relevant locations.*
- *4: The developer has an ISO 9000/AS9100 certified operation with recent AS9101 audit at relevant locations.*
- *3: The developer is meeting the intent of ISO 9000/AS9100 with a recent independent quality audit at relevant locations.*
- *2: The developer has an effective quality management system that includes suppliers with no recent independent audit.*
- *1: The developer has not demonstrated an effective quality management system.*

Rungs Facilitate 1) Self Assessment, 2) Training and 3) Steps for Improvement

Summary

- **Goal is to Continue to Improve Program Performance**
  - **Too Many Examples of Program Performance/ Issues Being Tracked Back to Lack of Systems Engineering Discipline**

- **Long Term Goal – Revitalizing Systems Engineering**
  - **Need to Follow "Best Practices"**
  - **Need to Do them "Well"**
  - **Need to Ensure that Our Program Teams Have What they Need**
    - **Qualified People, Process Discipline, Tools/Technology**

Where there is no standard there can be no Kaizen
– Taiichi Ohno

Kai-zen

The Art of Continuous Improvement

Kai-zen must operate with three principles in place: process and results, systemic thinking, and non-blaming (because blaming is wasteful).