

# Air Armament Center

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*War-Winning Capabilities...On Time, On Cost*



## Defining 100 Best Practices for SE

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**U.S. AIR FORCE**

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# Product Portfolio



# AMRAAM



HTS



MALD



BQM-167A



SDB



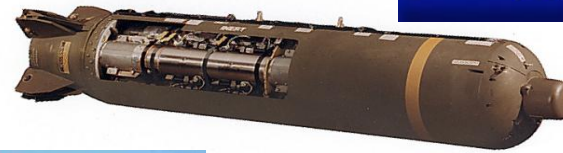
JASSM



FUZE



JDAM



SFW



UMT



ARTS



B-2 Shelter



# Outline



- **Air Armament Center  
Systems Engineering  
Assessment Model**
  - Why
  - How
  - What
  - Excerpts



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



# Direction & Goals



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

- 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”



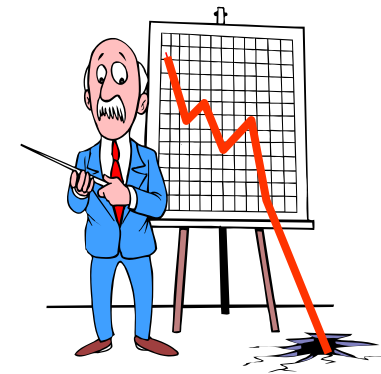


# Why We Need Change?



**AFMC**

- **Too Many Problems Have Surfaced**
  - Missed or Poorly Validated Requirements
  - Poor Planning Fundamentals
  - Lack of Integrated Risk Management
  - Lack of Rigorous Process
  - Lack of Process Flow Down
- **We Must Regain Our Credibility**
- **Restoring SE Discipline in AAC Projects Is a Key Initiative**



*Lack of Disciplined Systems Engineering  
has been a Major Contributor to Poor Program Performance*



# 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**



*2006*



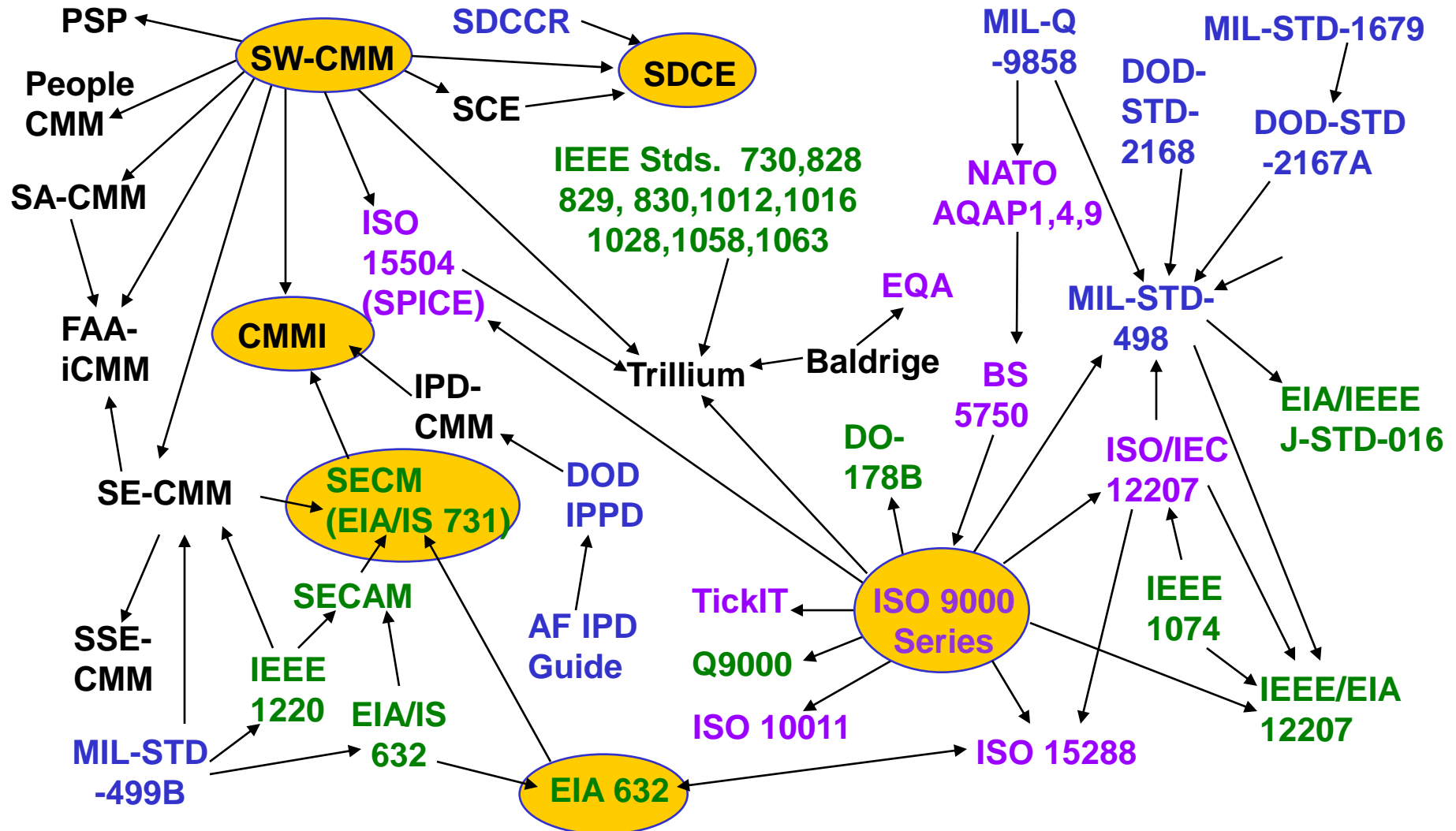
*2007-2008*



*2008-2009*



# SE Models & Frameworks

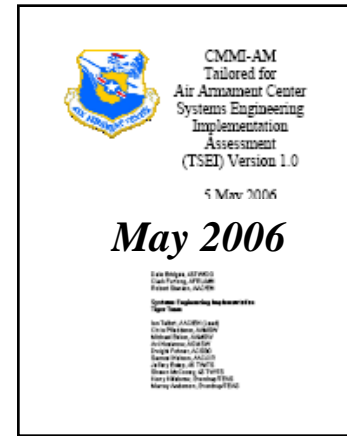
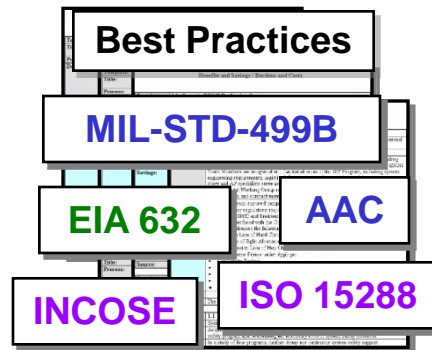
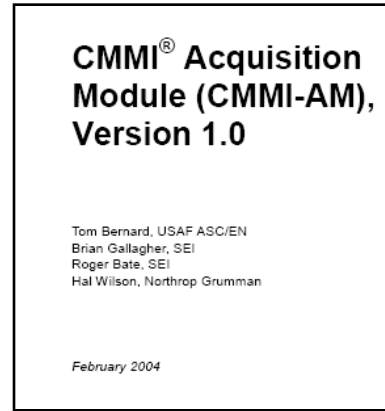




# Defining SE



- Center Engineering Steering Council
  - Defined Criteria
  - Approved Module & Approach



- 9 Key Process Areas
- 29 Goals
- 117 Practices
- 9 Generic Practices
- Qualifying Questions
- 43 Pages



**Industry/Academia**

- SEI, NDIA, Boeing, Raytheon, etc.
- USC, AFIT, etc.

**OSD Guidance**

- DAG
- SEP Guidance

**AF Guidance**

- AFI 63-1201
- AFPD OSS&E

**AFMCG Guidance**

- AFMCI 63-1201
- OSS&E

**Other Centers**

- ESC
- SMC

*AAC Assessment Module Based on International, Industry and DoD Best Practices*





# Benchmarking the Enterprise



### Process Area Criteria\*

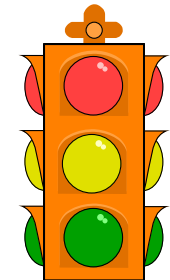
- >90% of Practices
- 65-89% of Practices
- <65% of Practices

### Program Criteria

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

\* Weighting  
SPs 75%  
GPs 25%

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



### Portfolio Criteria

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

PEO Set High Bar!



# AAC SE Assessment Model



- Engineering Council Provided Steering
- Working Level Team Did Heavy Lifting
  - Defined SE
  - Established Expectations
  - Facilitated Assessments
  - Training Benefits

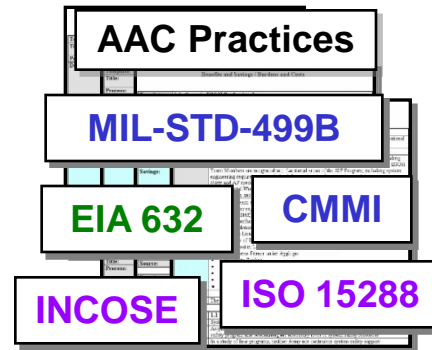
Systems Engineering Assessment Model (SEAM) Version 2.0  
Oct 2007

Engineering Council  
Daryl Israel, AAC/EN (Chair)  
Robert Arnold, AFM/ICA  
Dale Bridges, AFM/ISG  
Christopher Clay, 309 AR/SWEN  
John Cutler, AFM/CSO  
Clark Furlong, AFM/LAM  
Heath Holland, AFM/ENR  
Breck Mason, AF/CO

Systems Engineering Assessment Team  
Ian Talbot, AFM/EN (Lead)  
Manny Anderson, Jacob/TEAS  
Paul Brasca, 689 AR/SEN  
Christopher Clay, 309 AR/SWEN  
Harry Robinson, Jacob/TEAS  
Ken Lantz, 728 AR/SWEN  
James Schreiner, AFM/CSO  
Elizabeth Thom, 309 AR/SWEN  
Paul Torrey, Jacob/TEAS

## AAC-SEAM v2.09

- 10 Process Areas
- 34 Specific Goals
- 120 Practices
- 6 Generic Practices
- Qualifying Questions
- 50 Pages



**Industry/Academia**

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- USC, AFIT, etc.

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- DAG
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**AF Guidance**

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

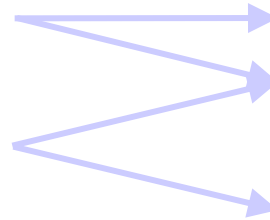


# Process Area Evolution



## • Technical Processes

- Requirements
- Design
- Verification/Validation
- Transition



## • Technical Processes

- Requirements
- Design
- Manufacturing
- Verification/Validation
- Sustainment

## • Technical Management Processes

- Planning
- Risk Management
- Configuration Management
- Decision Analysis
- Technical Assessment

## • Technical Management Processes

- Planning
- Risk Management
- Configuration Management
- Decision Analysis
- Technical Assessment

*Consistent with OSD Policy, Defense Acquisition Guidebook,  
Draft AFI on Systems Engineering & AFMCI 63-1201*

Version 1

Version 2



# Collaboration & Refinement



- **2007-2008 Goals**
    - Reduce Burden on Execution
    - Refine Alignment Between Module and DoD, AF, AFMC Guidance
  - **Formed AAC Tiger Team to Work on:**
    - Streamlining
    - Expanded Coverage
  - **Collaboration with OSD and Software Engineering Institute on Future of CMMI**
  - **AF Wide Collaboration to Develop Common SEA Model**
  - **Industry Collaboration**
- AAC-SEAM v2.4**
- 10 Process Areas
  - 33 Specific Goals
  - 115 Practices
  - 7 Generic Practices
  - 67 Qualifying Questions
  - 47 Pages

*Compliant with AF-SEAM v1.0*



# 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*



# Requirements Process Area



- **Purpose: Develop and analyze operational user, product, and product-component requirements**
- **Goals:**
  - **RG1: Stakeholder needs, expectations, constraints, and interface requirements are collected and translated into a definition of needed product capabilities/characteristics**
  - **RG2: Requirements are refined, elaborated and allocated to support product design**
  - **RG3: Iteratively analyze and validate operational and derived requirements throughout the product life cycle**
  - **RG4: Requirements are managed and controlled, and inconsistencies with technical plans and work products are identified**
  - **RG5: Generic practices are applied to the requirements process area**
- **13 specific & 7 generic practices to be assessed**



# Example Practice



## Key Process Area: Requirements

**Goal: RG4 - Requirements are managed and controlled, and inconsistencies with technical plans and work products are identified.**

### Practice:

P1 Use a disciplined process for accepting, vetting, approving and providing requirements and changes to the developer through a single focal point.

*This process should prevent developers from receiving requirements changes from unauthorized sources that are outside the flow of the acquirer's established configuration management process. Each change to a controlled requirement should be assessed for impact to the program's performance, cost, and schedule baselines and to program risk. The existing cost, schedule, and performance baselines should be changed, as required, to accommodate the requirements change. "Requirements creep" must be avoided. A new requirement must be backed with money and vetted through a control process.*

*Self Assessment Consists of Answering Yes, No or Not Applicable with Supporting Rationale to each Practice – No Partial Credit*



# Requirements



- **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**





# Planning



- **Integrated Plans for Managing (PPG2)**
  - Plan for Engineering, Data, Resources, Stakeholders, Technology, Reliability and Supportability. Maintain Integrated Master Schedule and Plans [CMMI].

*Are all technical plans integrated and consistent? How do you know?*

- At the fundamental level, planning includes understanding *what* must be done (scope of effort), *who* needs to do it (staffing and skills), *when* it needs to be done (life cycle and schedule), *how* it is to be done (reviews, methodology, tools, meetings etc...) and *how much* it will cost.

Reference: AAC SEAM v2.4



# Manufacturing



- **Plan for Transition to Production (RG1P2)**
  - **Establish Comprehensive Management Plans that Describe All Production Related Activities that Must Be Accomplished During Design, Test and Low-rate Initial Production [Willoughby].**

*Are all tiers of suppliers are involved in production planning?*

- **Implement Quality Management (MG4P1)**
  - **Monitor and Control Manufacturing Processes and Product Variation in all Tiers of Manufacturing [Willoughby].**

*How are process changes considered, authorized and implemented?*

Reference: AAC SEAM v2.4



# Testing and Sustainment



- **Verification and Validation (VG3 & VG5)**
  - Analyze and document the results of the verification & validation activities, identify issues, initiate and document corrective actions [CMMI].

*Is information on issues and corrective actions widely known?*

- **Plan for Logistic Support (SG1P1)**
  - Comprehensive Life Cycle Plan for Ensuring a Safe, Suitable and Effective Product [AFMCI].

*Are the critical failure modes addressed in maintenance activities?*

Reference: AAC SEAM v2.4



# Decision Analysis



- **Guidelines For Decision Making (DAG1P1)**
  - Determine Which Issues Are Subject To Formal Evaluation [CMMI].

*Do we understand when a formal analysis of alternative courses is indicated? Do we have the discipline to comply? ...*

- **Document Decision Rationale (DAG1P6)**
  - Including Dissenting Opinions [NASA]
  - Support Future Analysis [CMMI]

*Have we documented the decision including any concerns/issues? ... Sufficiently to support a re-examination in the next phase?*

Reference: AAC SEAM v2.4



# Final Thoughts



*“The Air Force is not funded to do everything that everybody wants us to do.”*

-- Hon Michael Wynne, SECAF

*So let's agree in AFMC we are done with the phrase "more with less."*

*Instead, I'd like us each to focus on doing the right things with the available resources. I want you to ask yourself the question, "with the resources I have at my disposal (time, funding, people, equipment, etc.) **what are the most important things I have to do?** " The corollary question then becomes, "**what must I stop doing so I can do those things?**" I recognize there are valuable things you might have to stop doing. I need each of you to take a hard look at your organization and determine what those things are.”*

-- Gen Bruce Carlson, Commander AFMC

*This is Great News for Systems Engineering Because we are All About Optimizing Systems!  
but We Must Have the Discipline and the Integrity to Make the Trades...*

改善

*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).*