Air Armament Center

Deliver war-winning technology, acquisition, test, sustainment
…expeditionary capabilities to the warfighter

U.S. AIR FORCE

Strengthening Systems Engineering Discipline

to NDIA CMMI Conf
15 Nov 2006

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AAC Portfolio

Outline

- Direction & Goals
- Approach
  - Process Focus
  - Multiple Spirals
- Spiral 1
  - Defining SE
  - Establishing a Baseline
  - Results & Observations
- Path Ahead
  - Analysis & Mining
  - Coaching ... Mentoring Improvement
  - Re-evaluating
- Final Thoughts

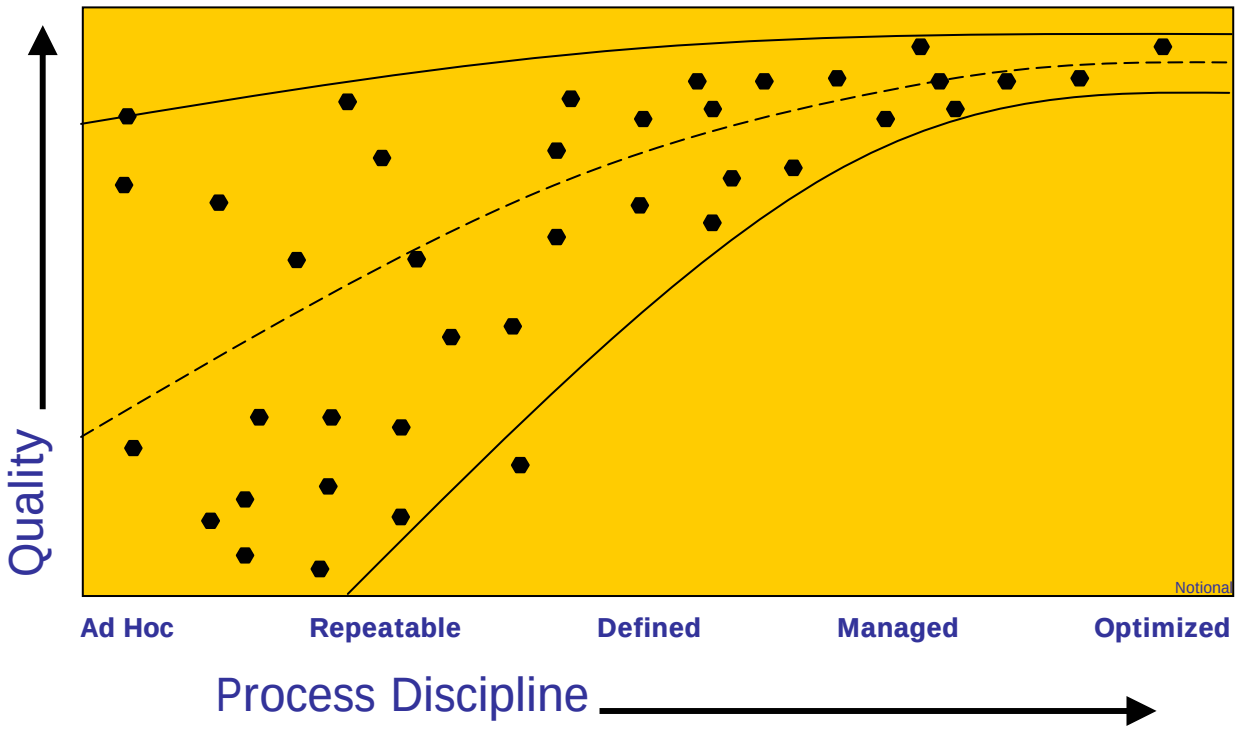
Direction & Goals

- Poor Systems Engineering Identified as Factor in Acquisition Program Problems & System Failures
- Recognized Need to Revitalize SE
- Engineering Tasked to:
  - Perform a Center-wide SE Assessment by Oct 06
  - Where are we?
  - Baseline Enterprise Process Improvement
- 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”

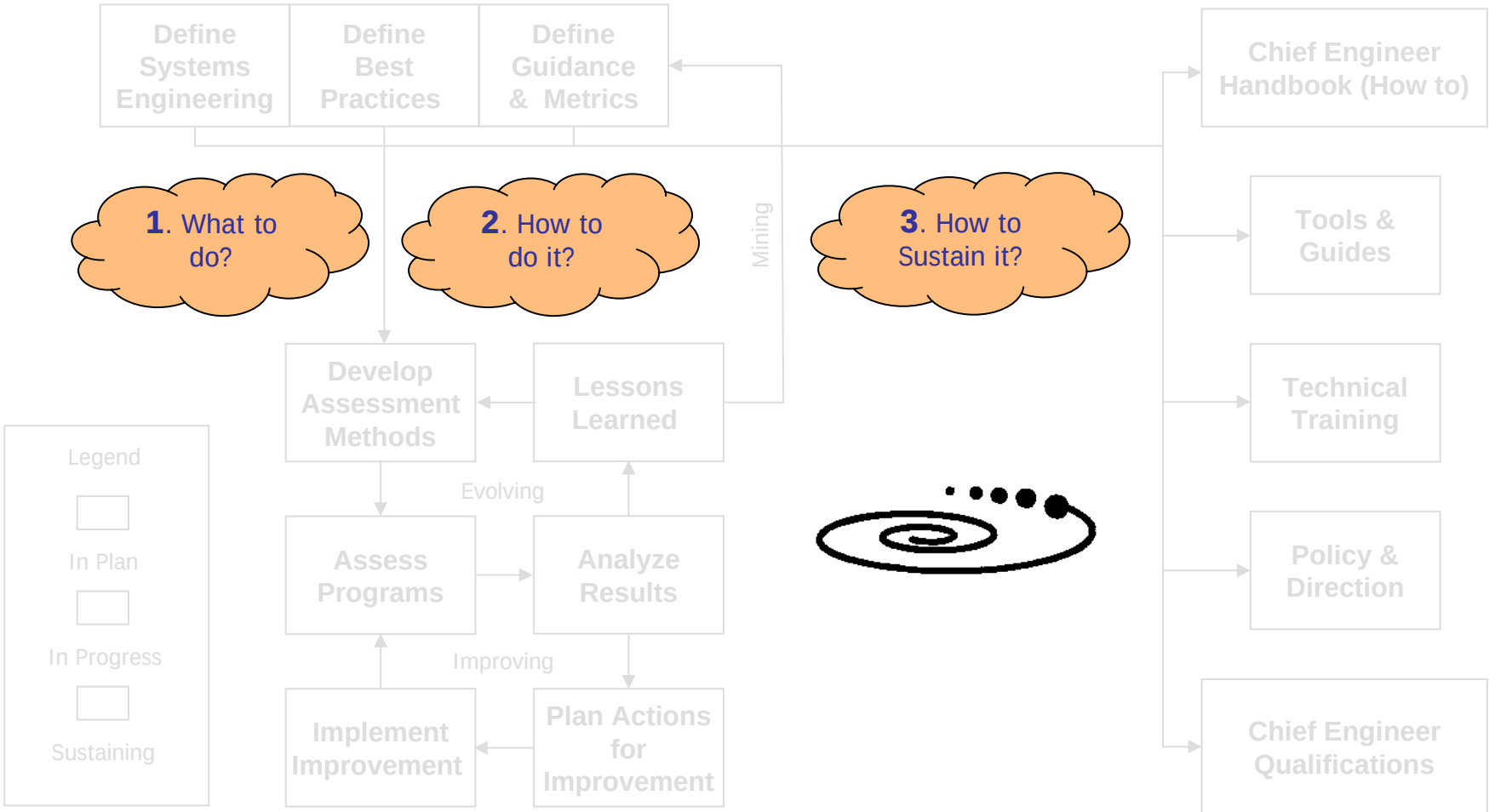
Institutionalized Process Driven SE » Lower Risk Technical Programs

Why Focus on Process

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

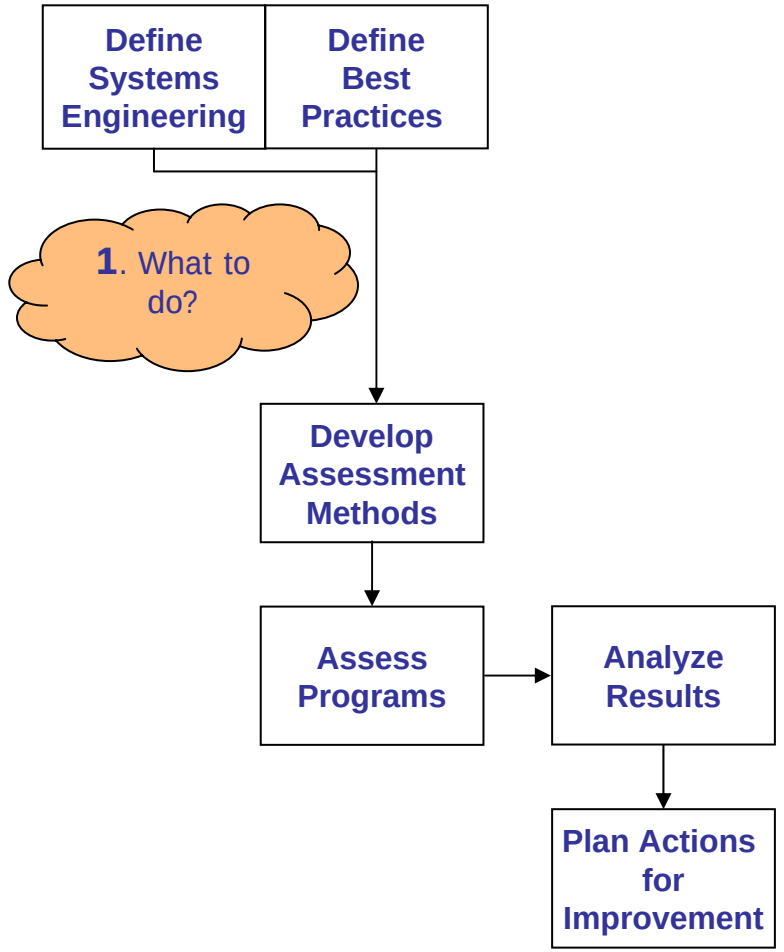


Spiral Approach



Institutionalized Process Driven SE » Lower Risk Technical Programs

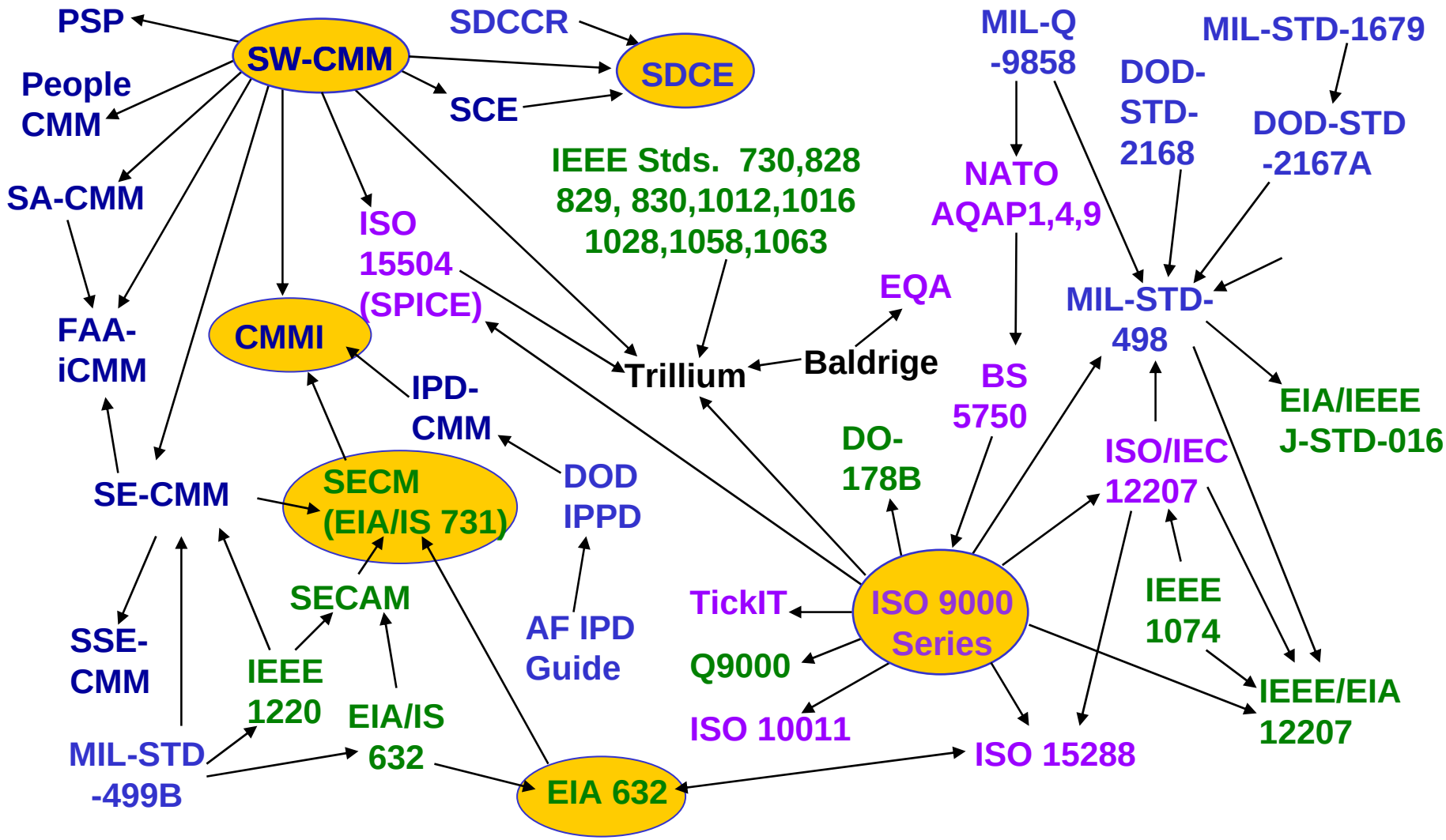
Spiral 1



- CY06
  - Define SE & Best Practices
  - Develop Assessment Methods & Tools
  - Train & Assess Programs
  - Analyze Results
  - Initiate Actions for Improvement

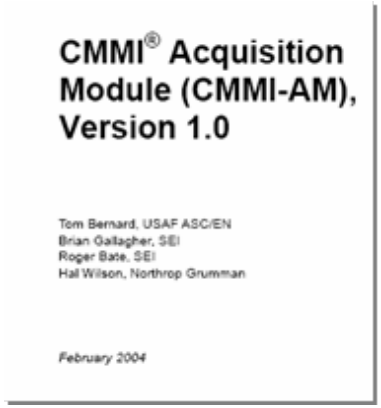
Focus is on Process/Practices not “Health” of Implementation

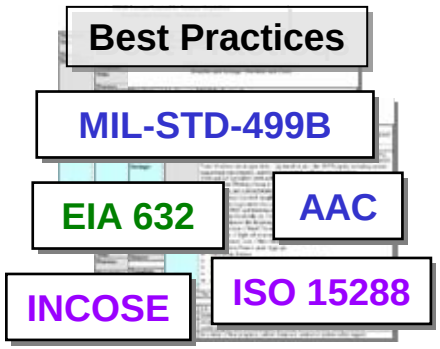
SE Models & Frameworks

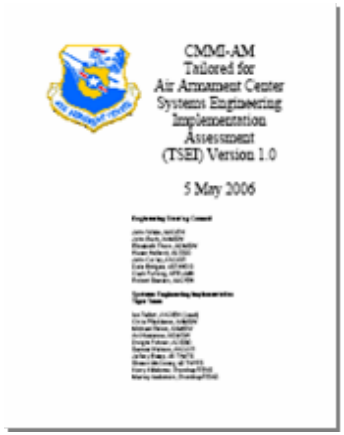


Defining SE

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







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

OSD Guidance
- DAG
- SEP Guidance

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

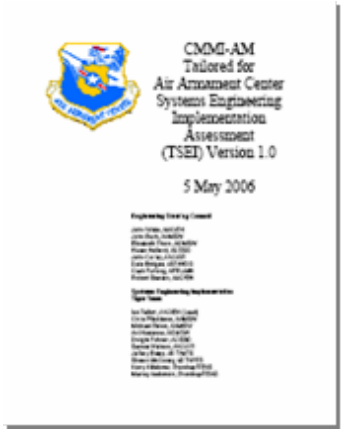
AF Guidance
- AFI 63-1201
- AFPD OSS&E

AFMC Guidance
- AFMCI 63-1201
- OSS&E

Other Centers
- ESC
- SMC

Key Process Areas

- Technical Processes
  - Requirements
  - Design
  - Verification/Validation
  - Transition
- Technical Management Processes
  - Planning
  - Risk Management
  - Configuration Management
  - Decision Analysis
  - Technical Assessment


CMMI-AM
Tailored for
Air Armament Center
Systems Engineering
Implementation
Assessment
(TSEI) Version 1.0

5 May 2006

Consistent with OSD Policy, Defense Acquisition Guide,
Draft AFI on Systems Engineering & AFMCI on OSS&E

CMMI-AM Tailoring

- What was tailored out
  - Elements not directly related to Systems Engineering (Contracting, Integrated Project Management, Logistics Support)
  - Section of Executive Questions that was Program Management and Enterprise Focused
  - Appendix addressing organizational process improvement

CMMI-AM Tailoring

- What was tailored in
  - Combined measurement and analysis and project monitoring and control and placed it in Technical Assessment
  - Strengthened reviews and audits in Technical Assessment
  - Combined requirements development and management in Requirements
    - Expanded to include elements from ISO-15288
  - Combined verification and validation
  - Developed Design consisting of Technical Solution, Architectures, Integration, Interface management
    - Drawn largely from CMMI-SE/SW/IPPD
    - Added “ilities” and Robust Engineering
  - Added DODAF architectures to Requirements and Design
  - Elevated Configuration Management from a generic practice and added some data management features
  - Added Manufacturing and OSS&E to Transition
  - Reduced Generic Practices from 12 to 9 and reordered them
  - Added Qualification Questions for each Goal

Example

Key Process Area: Requirements

Goal: RG5 - 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 of 117 Practices

SEA Methodology

Program does initial self assessment

2 Weeks
~55 person hours
execution

Program Self-Assessment

SEA Review Board

2 hours
~8 person hours
leadership

1 Week
~60 person hours
staff & execution

SEA Team Support

Co-chaired by Line EN Functional and Center Chief Systems Engineer, attended by Program Leadership and SEI Team Lead

Scrubs answers reviews data provided

Spiral 1: Assess What Practices are Implemented NOT How Well they are Being Executed

Spiral 2: Shift Focus to “How To” and Quality of SE Implementation

Enterprise View

Legend

R – Requirements **V - Ver/Val** **P – Planning** **CM - Config Mgmt** **TA - Tech Assessment**
D - Design **T - Transition** **RM - Risk Mgmt** **DA - Decision Analysis**

Key Process Areas

as of 18 Oct 06	R	D	V	T	P	TA	RM	CM	DA	Pgm
Program #1										B
Program #2										A
Program #3										C
Program #4										B
Program #5										B
Program #6										C
Program #7										C
Program #8										F
Program #9										C
Program #10										B
Program #11										
Program #12										C
Program #13										A
Program #14										B
Program #15										B
Program #16										B
Program #17										
Program #18										
Program #19										C
Center Average	**C**	**B**	**B**	**B**	**C**	**B**	**B**	**A**	**F**	**C**

High Bar

Scoring Criteria

Process 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**

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

Process Area View

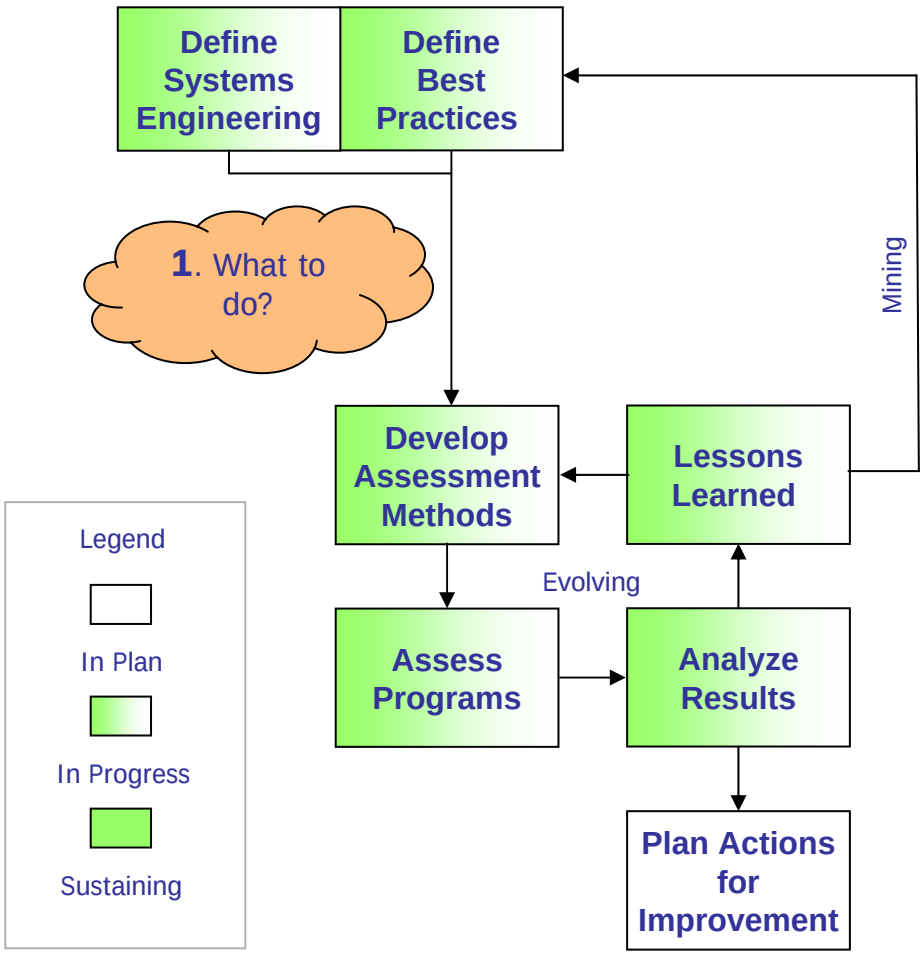
Decision Analysis	**RED**
Planning	**YELLOW**
Requirements	
Technical Assessment	
Risk Management	
Verification & Validation	
Transition	
Design	
Configuration Management	

Better

Scoring Criteria

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

Spiral 1 Observations



- Process
  - Mostly Well Received
  - Training was a Time Saver
  - More Emphasis Needed
    - Production/Integration & Sustainment
- Programs
  - Few Documented Processes
  - Greater Benefit for Smaller
  - Some Saddled with Difficult SE Strategies
    - 1067s, not COTS
- Wants
  - Chief Engineers Handbook
  - Offeror Capability Reviews
  - Metrics for SE Health

Analyze Results

- Systemic Analysis
  - Enterprise Wide Issues – Gaps
    - Understanding
    - Standards
    - Training
  - Specific Areas of Strength
    - Mining of Best Practices
  - Leadership from the Functional
- Programmatic Analysis
  - Program Specific Practice Shortfalls
  - Leadership from Line Functionals
  - Functional Organization Provides Support

Systemic Analysis

Legend

R – Requirements **V - Ver/Val** **P – Planning** **CM - Config Mgmt** **TA - Tech Assessment**
D - Design **T - Transition** **RM - Risk Mgmt** **DA - Decision Analysis**

Weakness

Strength

Key Process Areas

R	D	V	T	P	TA	RM	CM	DA
69	95	86	84	85	97	97	100	49
94	97	93	81	86	100	94	100	71
81	97	81	92	69	76	43	97	58
89	94	64	89	89	86	92	97	76
81	65	90	94	57	79	71	94	0
42	33	38	54	32	40	66	38	38
82	89	67	89	81	81	94	92	76
49	54	89	46	64	43	85	47	79
77	86	73	86	78	86	67	94	49
90	100	100	86	86	86	100	100	71
88	100	89	83	86	100	70	100	49
86	100	82	100	86	92	86	100	74
88	100	96	92	82	83	80	94	76
43	70	90	86	82	86	92	94	46
76	**84**	**81**	**83**	**76**	**81**	**81**	**89**	**58**

EN Directorate Focus on Areas Indicating Enterprise Weakness
- e.g. Decision Analysis, Requirements, Planning

Systemic Issues/Actions

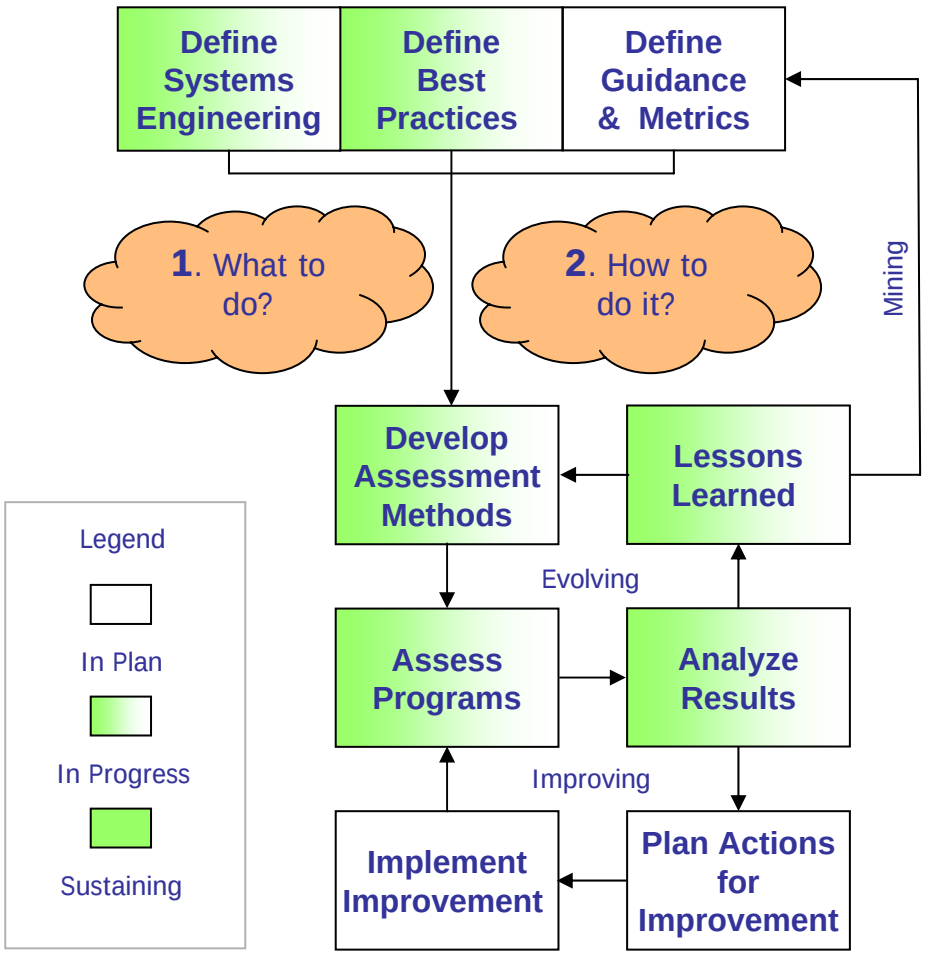
- Planning & SEPs
  - Lack of Clear Definition for Technical Planning, AF Policy Advancing
  - Refine Local Process Guidance, Tailoring, Add Elements & Train
- Requirements
  - Lack of
    - Comprehensive Use Cases / Mission Profiles
    - Requirements Validation
    - Life Cycle Stakeholder Involvement
  - Specific Shortfalls Treated through General Training & Technical Planning Course
- Decision Analysis
  - Lack of Rigorous Process
  - Define Process
  - Obtain Buy In
  - Establish & Train Process

Mined Best Practices

- 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 2



- FY07
  - Continue Analysis of Results to Identify Gaps & Mine "How to" Best Practices
  - Evolve Assessment Methods
  - Implement Mechanisms & Framework for Coaching / Advising ... Programs
    - Share Results & Coordinate Improvement Efforts
    - Continue Development of Community of Practice
    - Initiate Development of Chief Engineers Handbook
  - Implement Specific Action Plans to Address Areas of Weakness

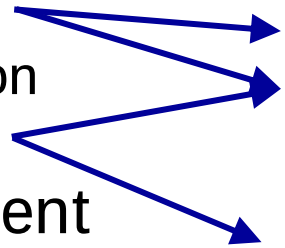
Shift Focus to "How To" and Quality of SE Implementation

Evolve SEA Methods

- Gaps
  - "Valley of Death"
  - Need to get to "Health"
  - AFMC Policy
    - Sustainment Emphasis
- Action Plans
  - Mine Lessons Learned from Programs that Bridged the Valley
  - Mine Willoughby Templates
  - Map Shalls from New AF Policy
  - Expand Module to "Health"

Tool Expansion/Reorg

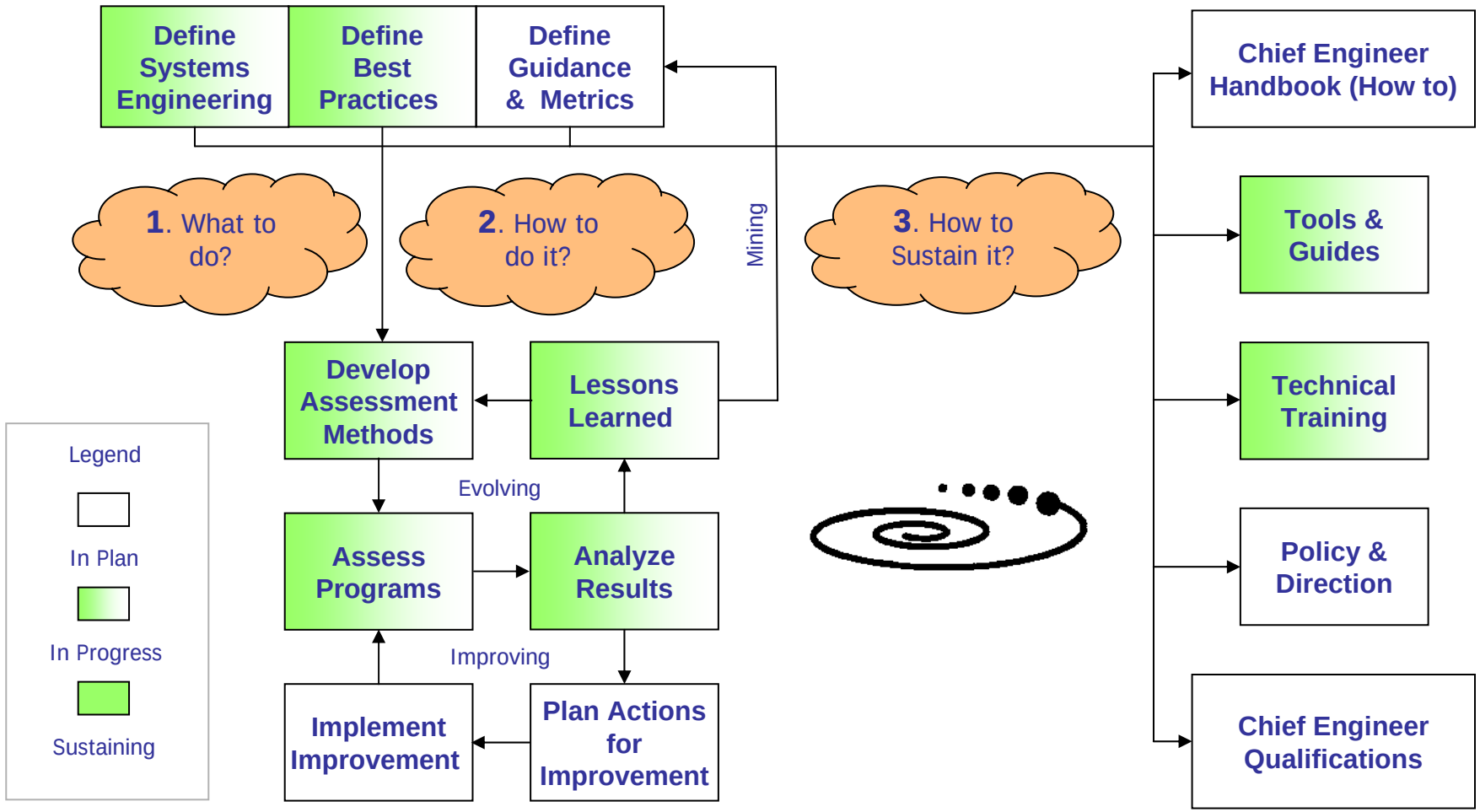
- Technical Processes
  - Requirements
  - Design
  - Verification/Validation
  - Transition
- Technical Management Processes
  - Planning
  - Risk Management
  - Configuration Management
  - Decision Analysis
  - Technical Assessment



- Technical Processes
  - Requirements
  - Design
  - Transition (to production)
  - Verification/Validation
  - Sustainment
- Management Processes
  - Planning
  - Risk Management
  - Configuration Management
  - Decision Analysis
  - Technical Assessment

Improve Alignment Between AAC Tools and AFMCI

Spiral 3



Institutionalized Process Driven SE » Lower Risk Technical Programs

Final Thoughts

Credit to Jeff Haars

- Process Orientation
  - AAC History of Success Due to “Heroes” Not Rigorous Process
  - Process Approach Will be Paradigm Shift
- Enterprise Process Group
  - Process Approach Needs a Process Group
  - Dedicated Group
  - Process “Keepers”
  - Mentors ... Coaches
- Self-Assessment
  - Easy Entry to Process Approach
  - Followed-up by External Audit
- Investment Required
  - Vetting and Maintaining Documentation and Compliance Measures...
  - Audits, Auditors, Process Group...
  - Education & Training

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