NAVAL AVIATION ENTERPRISE

A WARFIGHTING PARTNERSHIP

SINGLE PROCESS OWNER

AND OUR INDUSTRY PARTNERS

SINGLE FLEET DRIVEN MEASURE OF SUCCESS:

AIRCRAFT AND CARRIERS READY FOR TASKING AT REDUCED COST
P-8A MMA Configuration

- Common cabinets for ease of access and maintenance
- Room for growth—23% more floor space than P-3
- Improved power distribution with reserve
- Improved ECS for increased electronics MTBF
- High speed (.82 Mach) and high altitude (41K max)
- Modern open system architecture
- Improved crew accommodations
P-8A MMA Acquisition Snapshot

**FY00-02: CE**
- Boeing
- Raytheon
- EADS
- BAE
- Lockheed Martin
- UAV’s

**FY02-04: CAD**
- Multiple contracts awarded for MMA system
  - Defined MMA system architecture
  - Thorough risk analysis
  - Validated Operational Requirements Document (ORD)
  - Detailed cost analysis

**FY04-13: SDD**
- Boeing contract award 14Jun04
- Fleet involvement thru FIT & ITT
- 7 flight test aircraft
- Total planned inventory – 108

**FY00-02: CE**
- Definition of MMA system architecture
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**P-8A Spiral ONE**
Component Advanced Development

2 Yr Risk Reduction Effort

- System Architecture
- Alternative Concept Studies
- Total Ownership Cost Analysis
- System Performance Requirements To Meet ORD/CDD
- CAD
- Detailed Risk Analyses
- Overall Test Strategy
- Provisions For UAV Integration

Risk Management

- Low
- Medium
- High

Graph showing Risk Management over Program Start, Pre-Proposal, and Milestone B.
Key Lessons Learned

- Lack of adequate program maturity at MS B
  - Ill defined requirements
  - Lack of robust requirements management
  - Risky technical approach
- Failure to involve independent technical community at program initiation
- Lack of early independent cost analysis (AIR-4.2) in POM/PR
  - Ill defined CARD
  - O&S costs not well understood
  - Failure to budget for long lead items
  - Test program correction of deficiencies not adequately planned for
- Lack of technical insight & risk management process
  - Lack of automated SE tools
  - Inadequate use of metrics
  - Lack of appropriate technical expertise
- Government acting as integrator by default
- Inadequate program technical staff and future staffing plans
- Lack of horizontal/vertical SE integration (i.e., Battlespace Engineering, Aviation/Ship integration)
- Overly optimistic Acq/PM strategy/schedule
- Comprehensive use of EVM and TPMs
Back-Up
DAU Program Start-up Workshop

• Set the foundation for SDD success

• Many DoD programs struggle or fail due in part to:
  – Lack of common Vision and plan for success
  – Lack of supportive environment
  – Disagreements over program baseline

• Foster sense of trust, teaming, and honest discussions

• Produced useful Workshop products

• Educated Industry on Govt’s Warfighter Requirements

• Educated Government on Industry “Best Practices”

Key Accomplishment: Taking the time to have Navy and Boeing Team Lead counterparts sit down with one-another in a relaxed forum to discuss broad based and team focused challenges.
P-8A MMA Manufacturing Flow

Spirit AeroSystems
Wichita, Kansas
MMA Fuselage

Boeing Commercial Airplanes
Renton, Washington
MMA wings, empennage, aircraft assembly, engine installations

Boeing Integrated Defense Systems
Seattle, Washington
Mission systems/I&CO

SDD and Production

Aircraft delivery
P-8A MMA Acquisition Strategy

- Structured on an evolutionary systems replacement approach
  - Established sound program foundation based on an iterative requirements definition process with warfighters and industry, thorough risk analysis of competing concepts, and detailed cost analysis of evolving concepts
  - Provides a transformational product in minimal time to users while promoting evolutionary growth in capabilities through spiral development
- Defined in a capstone document that summarizes individual statutory and regulatory plans in order to communicate to leadership the total discipline approach to acquiring a system that recapitalizes the capabilities now provided by the P-3C
Naval Systems Engineering Process

- Documented in Naval Systems Engineering Guide
- Identifies 13 Processes and 33 Sub-processes for engineering a system
- Provides information regarding inputs, outputs, entry criteria, exit criteria, references, agents, tools and methods that Navy engineering teams may use to accomplish each Sub-process.
Technical Review Timeline

**Systems Engineering Technical Review Timing**

**Phases**
- Concept Refinement
- Technology Development
- System Development & Demonstration
- Production & Deployment
- Operations & Support

**Activities**
- Pre Systems Acquisition
- Systems Acquisition
- Sustainment

**Work Efforts**
- Concept Decision
- System Integration
- Design Readiness Review
- Full Rate Production & Deployment
- Sustainment

**Instruction & References**
- Reviews: ITR, ASR, SRR, IBR, SFR, PDR, CDR, TRR, FRR, OTRR, SVR/PRR, PCR, ISR
- Cost Validation: Analogy/Parametric Based on System Performance Specification, Analogy/Parametric Based on System Functional Requirements, Analogy/Parametric Extrapolation of Actual Preliminary Design Packages, Refined Cost Estimate Based on Detailed Design Drawings, Engineering Extrapolation of Actual Design Package

**Technology Readiness Assessment**
- Technology Readiness Assessment (TRA)
- Technical Reviews (ITR, ASR, SRR, IBR, SFR)
- Program Reviews

**Cost Estimation Uncertainty**
- Greater Cost Estimation Uncertainty
- Moderate Cost Estimation Uncertainty
- Lower Cost Estimation Uncertainty

**Reviews**
- ITR - Initial Technical Review
- ASR - Alternative System Review
- SRR - Systems Requirements Review
- IBR - Integrated Baseline Review
- SFR - System Functional Review
- PDR - Preliminary Design Review
- CDR - Critical Design Review
- TRR - Test Readiness Review
- FRR - Flight Readiness Review
- OTRR - Operational Test Readiness Review
- SVR - System Verification Review
- PRR - Product Readiness Review
- PCR - Physical Configuration Review
- ISR - In Service Review
Integration of Requirements Refinement, Concept Definition, and Cost Analysis
P-8A MMA Requirements Evolution

### Pre-MS Activities
- 1998 Requirements Analysis Study
- COST, TECHNICAL SCHEDULE FACTORS
- 1999 Technical and Economic Feasibility Assessment

### Concept Exploration
- INDUSTRY CONCEPT STUDIES
- ANALYSIS OF ALTERNATIVES
- DRAFT CAD RFP
- INDUSTRY COMMENTS
- CAD RFP
- CAD AWARDS

### Component Advanced Development
- CAD PHASE MISSION/SYSTEMS EFFECTIVENESS ANALYSIS AND COST/PERFORMANCE TRADES

**Validated ORD**
- Block I
- Block II
- ...
- Block N

<table>
<thead>
<tr>
<th>Pre-MS Activities</th>
<th>Concept Exploration</th>
<th>Component Advanced Development</th>
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<td>1999 Technical and Economic Feasibility Assessment</td>
<td>DRAFT CAD RFP</td>
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<td>MNS FEB 00</td>
<td>INDUSTRY COMMENTS</td>
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<td>IRD 1 OCT 01</td>
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<td>IRD 2 DEC 01</td>
<td>CAD AWARDS</td>
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<td>IRD 3 FEB 02</td>
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<tr>
<td>DRAFT ORD JUL 02</td>
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</tr>
</tbody>
</table>
Road to Milestone B:
- Source Selection for SDD
- Concept Development and Risk analysis/reduction
- Requirements definition, refinement, & validation (Pre-MS B SRRs w/each competitor)
- Concept Cost Analysis

Effective integration of discrete activities, orchestrated to execute in a concurrent, effective manner
SDD Systems Engineering Process and Major Products

Customer requirements database
- ORD/CDD
- MMA PBS
- CONOPS DRM

Requirements analysis
- PBSS
  - SS Specifications
  - SCDs
  - SRSs
  - ICDs
  - IDD(s)
  - Test plans

Functional analysis
- Functional model
- Allocation and synthesis

Functional model
- Trade Studies
- Program and Technical Plans

Requirements loop
- PBSS
- Requirements analysis

Design loop
- Performance Specifications
- Design Trades
- Preliminary Product Specs
- Preliminary Verification Plans

Design loop
- PBSS
- Functional analysis

Build and dev test loop
- PBSS
- Functional model
- Allocation and synthesis

Legend:
- SRR
- SFR
- PDR
- CDR

Systems Analysis and Control
Assessment and Balance of Technical Risk, Cost, and Schedule
P-8A MMA System Preliminary Design Baseline Specification Tree (CI/CSCI) in DOORS

**Level 1 System Functional Baseline**
- Functional Description Document
- Core use case analysis

**Level 2 Allocated Baseline**
- Aircraft System Segment Specification
- Mission System Segment Specification
- Logistics System Segment Specification

**Level 3 Product Baseline**
- PBSS
- ORD/CDD

**Requirements Volatility**
- 31 reqt changes
- 1,240 requirements
- 2.5% = Requirements Volatility

**Legend:**
- SRR
- SFR
- PDR
- CDR
- Future input to DOORS
Key Processes

- Systems Engineering Plans and Process (SEP and SEMP)
- Configuration Management Process
- Technology Readiness Assessment (TRA) Process
- Trade Study Process
- Risk and Opportunity Management Process
- Technical Performance Measures (TPMs) Process
- Human Systems Integration Plan
- Electromagnetic Environmental Effects (EEE) Plans
- Contractor Logistics Support (CLS) Plan
- System Security Plans
- System Safety Plans
- Interface Control and Interface Management Plans
- Producibility
- Quality System Plan
Technology Readiness Assessment

- Conducted during CAD
  - Independent assessment panel consisting of members from the Naval Air Systems Command (NAVAIR), Office of Naval Research (ONR), and academia (John Hopkins University Applied Physics Laboratory (JHU-APL)).

- TRA identified four Critical Technology Elements (CTEs) through a comprehensive review of the MMA program work breakdown structure (WBS) reflecting the Boeing CAD phase configuration baseline prior to SDD source selection
  1. Integrated Sonobuoy Launcher System
  2. Electronic Support Measures (ESM) system
  3. Data Fusion
  4. Acoustics Subsystem

- None of the P-8A CTE impact ability to meet program Key Performance Parameters (KPP)
Risk Management Process

Major Process Tasks for: Risk Management
MMA Program Management

Any Team Member

Program Risk Review Board (PRRB)

IPT Leader

IPT

Affordability

Risk Owner

Program Risk Review Board (PRRB) or Team Risk Review Board (as applicable)

Who

Function or Individual

Responsible

Input

Output

- Fully integrated RMB with Industry
- Definition and implementation of process
- Facilitated by Boeing IDE

LEGEND

- Start or End
- Task
- Decision
- Connector
- Quality Record

- CWIP
- LEAN

- Yes
- No

- Program-Level Risk?
- Team-Level Risk?
- Program- Level Risk?
- Risk Mitigation Plan Accepted?
- Risk Mitigated?
- Risk Rejected

- A
- B

- CWIP
- LEAN

- Beginning Boundary Task Identify and Submit Risk Candidates

- Promote Risk?
- Valid Risk?
- Managed Risk?
- Risk Mitigated?
- Continue with Risk Mitigation Plan?
- Review Status of Risk & Plan
- Control Risk & Implement Plan
- Plan Handling Options/ Mitigation and Fallback Plan, if necessary
- Review Plan
- Risk Mitigation Plan Acceptable?
- Relinquish Risk Mitigation Plan
- Watch Item
- Assign / Re-Assign Owner
- Assess Risk Likelihood and Consequence
Opportunity Management
The Sister of Risk

Opportunities
- **HIGH** (Gold) - Major benefit likely. Priority management attention required.
- **MEDIUM** (Silver) - Some benefit. Additional management attention may be required.
- **LOW** (Bronze) - Minimum benefit. Minimum oversight needed to pursue opportunity.

Risks and Opportunities Matrix

**IDENTIFY Opportunity**

**ASSESS**
- Likelihood & Consequence
- 5x5 Opportunity Assessment Matrix

**PLAN**
- Capture, Transfer, Ignore, or Pursue the Opportunity
- Establish Opportunity events, Responsibilities and Schedules

**CONTROL**
- Monitor Actions, Correct Deviations, and Re-plan as Appropriate
- Promote or Demote Opportunity as Appropriate

**COMMUNICATE**
- Populate Database, Keep it Current, and Make it Accessible to All
## TPMs
(Status as of 14Jul06)

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<th>Mission Perf./Radius of Action</th>
<th>nm</th>
<th>1,135</th>
<th>1,200</th>
<th>1,265</th>
<th>1,330</th>
<th>1,395</th>
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<td>A/C Operating Weight (Klb)</td>
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<td>111,448</td>
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<td>Aerodynamic Drag (counts)</td>
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<td>377.9</td>
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<td>371.9</td>
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<tr>
<td>Operational Availability (%)</td>
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<td>77.9</td>
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<td>Electrical Power Util (kVA)</td>
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<td>243</td>
<td>226</td>
<td>209</td>
<td>192</td>
<td>175</td>
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<td>ECS Thermal Utilization (kW)</td>
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<td>90.0</td>
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<td>MCDS CPU Utilization (OMI) %</td>
<td>of target</td>
<td>65</td>
<td>60</td>
<td>55</td>
<td>50</td>
<td>45</td>
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<td>MCDS Lan Utilization %</td>
<td>of target</td>
<td>70</td>
<td>65</td>
<td>60</td>
<td>55</td>
<td>50</td>
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<tr>
<td>MCDS Memory Utilization %</td>
<td>of target</td>
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<td>50</td>
<td>45</td>
<td>40</td>
<td>35</td>
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<tr>
<td>MCDS Storage Utilization %</td>
<td>of target</td>
<td>120</td>
<td>100</td>
<td>90</td>
<td>80</td>
<td>60</td>
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<tr>
<td>EMI (cosite margin) counts</td>
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<td>33</td>
<td>30</td>
<td>27</td>
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<td>Operations &amp; Support Cost</td>
<td>normalized</td>
<td>1.10</td>
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<td>.95</td>
<td>.90</td>
<td>.85</td>
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<td>Production Unit Cost (04 $ in Mil)</td>
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<td>Interoperability (# of PBSS IERS)</td>
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<td>9</td>
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<td>39</td>
<td>54</td>
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<td>Worst Case PBS survivability % Sur.</td>
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<td>1.04</td>
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<td>Vulnerability Av %</td>
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<td>1.2</td>
<td>1.1</td>
<td>1</td>
<td>.9</td>
<td>.8</td>
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<tr>
<td>Fusion Track Accuracy Heading</td>
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<td>1.1</td>
<td>1</td>
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<td>.8</td>
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<td>C31SR Initial On Station Alt. (Ft)</td>
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<td>15,000</td>
<td>25,000</td>
<td>30,000</td>
<td>35,000</td>
<td>45,000</td>
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<td>ASW Weapon Loadout In work</td>
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<td>36,402</td>
<td>36,643</td>
<td>36,543</td>
<td>36,463</td>
<td>36,483</td>
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KPPs

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<tr>
<th>Range</th>
<th>Ao</th>
<th>Interop</th>
<th>Alt</th>
<th>ASW wt</th>
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IOC = 0

under review
SRR Lessons Learned

• Joint team attitude to address issues openly and overtly and proactively run actions to ground as a high priority during and after review will continue to serve program well. Critique acceptance and addressal will assist in successful execution and maintains credibility.

• System Specification had moderate instability post-SRR due to Segment SRRs and the decomposition and allocation of requirements as the functional baseline was established (expected in the SE iterative loop, level of System Spec stability a good indicator of solid CAD phase and SRR).

• A robust requirements management tool (i.e., DOORS) with clear, clean links from top-level (CDD/Performance) requirements down through all levels of the specification tree to detailed requirements (at PDR/CDR) is essential.
SFR Lessons Learned

- Derived Mission Functions and associated architectural flow needs to be kept alive under change control as a living part of the design baseline.
- Functions and associated allocations must be used by product teams to identify and reconcile gaps in requirements.
- Product team System Use Cases and associated functions must be linked to Transactional Mission Use Cases to identify and reconcile functional gaps (Software functional areas in particular).
- Trade Studies and Design Changes must consider the specification tree from top to bottom including the linked functions (DOORS extracts used at CCBs).
- SFR preparation improved intra- and cross team communication.
- SFR preparation led to customer ‘buy in’ on technical approach and maturity.
- SFR preparation led to an exponential increase in the number of System Level Requirements experts, and Mission Usage experts.
PDR Lessons Learned

• EVM implementation and team utilization is a continual study and refinement process to ensure proper CAM focus and Team Lead expectations are understood

• IDE is a productivity multiplier for team communications and insight into program status

• Value of design reviews is the build up and incremental review preparation process leading to the early identification of risks and issues to program execution

• Government teams expend considerable energy working processes and communications with the Prime contractor; the same needs to occur between the Prime and subcontractors

• Efficient budget execution is the best defense for budget development and prioritization
A Quality Team

SDD

A Rock Solid Foundation
Of Respect and Trust
Firmly Supporting an Environment
Of Common Goals
Transition into SDD

• Contract award – 14 June 2004
  – Required completion of Source Selection prior to Milestone B
  – Approval from MDA to enter SDD through the Milestone B DAB
    • Approval of Acquisition Strategy
    • Determination of fully funded program based on CAIG assessment
    • Approval of Acquisition Program Baseline

• Teaming with Industry – Program Start-up Workshop
Program Best Practices for SDD

- Management by Metrics
  - Risk Management Process
  - Opportunity Management
  - Technical Performance Measurement
  - Earned Value Management
Earned Value Management Reporting Via Tier IV IMS

Integrated Master Plan (IMP)
- Program Master Schedule Tier I
  - Program summary
  - Major milestones

Program Element Schedule Tier II
- Major program elements
- Customer and ACA interfaces

Product Schedule Tier III
- Cross-functional integrated baseline
- Key interface milestones

Control Account Schedules Tier IV
- Detailed, measurable tasks
- Vertically linked: IMP, IPTs
- Horizontally linked: account

Increasing Level of Detail

IMS from contract award through PDR: 20,141 tasks resource loaded (labor-hours)

CAMS

CAMS

CAMS

CAMS

CAMS
Integrated Baseline Review

**Purpose** – Achieve mutual understanding of baseline plan and relationship to underlying EVMS and processes during contract execution

**Objectives** –

- Evaluate the performance measurement baseline to ensure:
  - Entire technical scope of work captured
  - Sufficient contract budget and schedule
  - Budget properly allocated at the right level
  - Resources adequately assigned
  - Proper implementation of management processes
- Gain insight into cost and schedule risk areas associated with contract
- Develop confidence in the program’s operating plans