Rapid Integration of the M197 onto the MH-60S
– Abstract 11584

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**NSWC Crane Division**

**Stewards of 14 NAVSEA Technical Capabilities**

**NSWC Crane Mission Focus Areas:**
- Special Missions
- Strategic Missions
- Electronic Warfare / Information Operations

**Four Outputs:**
- Knowledge
- Contracts
- Hardware
- Software

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**NSWC CRANE**
- Located on 3rd Largest Navy Installation in the World
- No Encroachment & Unencumbered
  - Detachment at Fallbrook, CA

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Small Arms Air Platform Integration

• Who are we?
  – We are a team of engineers, logisticians, and technicians with vast crew served weapons and electronics integration experience.
  – We have the capability to support the full life cycle of the systems we deploy.
  – We support multiple platform offices and team with industry partners.
  – We take great pride in providing high quality support to our customers in a timely manner.

• What do we do?
  – Design and integrate weapon systems for various aircraft.
  – Fabricate prototype parts for fit checks and testing.
  – Support flight certification process through the NAVAIR Performance Monitors.
  – Provide Finite Element Analysis (FEA) modeling for fatigue and crash loads.
  – Procure production hardware through GOV contracts.
  – Receive, inspect, kit, and deploy high quality systems.
  – Provide interim supply support.
Rapid System Integration

• How can we rapidly integrate weapon systems at a reduced cost that will provide enhanced capability for the fleet?
• How are we using Systems Engineering to solve this?
Systems Engineering Plan

- Established the Process or Guidelines for the Project
- We used applicable Systems Engineering Guides to derive a tailored Systems Engineering Plan
- Used NAVAIR Systems Engineering Technical Reviews (SETR) Guide to establish Checklists and Entrance/Exit Criteria
Tailor vs. Cut

- The use of ‘Tailor’ instead of ‘Cut’ was key to our systems engineering process
  - Tailor: to fit to a particular circumstance
  - Cut: reduction; break off

- Key Questions:
  - How can we apply guides and instructions written for an ACAT I program to a small rapid development effort?
  - What is the purpose of the process/document?
  - Does the purpose add value to the program?
  - How can we benefit from the purpose within cost and schedule?

- Readdressed how we ‘Tailor’ the Guides and Instructions to ensure we’re meeting the intent of the document

- Putting ‘Pen to Paper’ forces tough decisions to be made early and greatly aid in the planning process and gets everyone on the same page
Work Breakdown Structure

- Scoped the Project and Defined Artifacts
- The WBS was created to capture the total effort to support the development, integration and fielding of the 20mm Gun System.
- Based on MIL-HDBK-881A
- Contains a WBS Dictionary for each element.
- Established Common Terms.
- Assigned each WBS Element to a Functional Lead
• Established a Team that could execute the work
• Involved Non-Design Functional Areas from the start of the project
Areas of Responsibility

**Project Lead**
- Stakeholder Mgt
- Decision Analysis
- Technical Assessment
- Configuration Mgt
- Data Mgt
- Contract Mgt
- Risk Mgt
- Validation

**Test Lead**
- Test Planning
- Component Testing
- Subsystem Testing
- System Functional Checkout
- Test Execution
- Test Coordination

**Systems Engineer**
- Technical Planning
- Requirements Mgt
- Requirements Analysis
- Architecture Design
- Implementation
- Interface Mgt
- Verification

**Logistics Lead**
- Logistics Documents
- Training

**Electrical Lead**
- Electrical Design
- Electrical Component Fabrication

**System Safety Lead**
- WSESRI B Data Package
- LSRB Data Package
- System Safety Planning

**Mechanical Lead**
- Mechanical Design
- Hardware Fabrication

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Death by Meetings?

- Enforce Time Limits
- Working Meetings
- Follow an Agenda
- Stay Focused
- Low Preparation Workload
  - Most Preparation is Day-to-Day Tasking
- Follow Up
- Clear Expectations

- IPT Meeting
  - Weekly
- Sponsor Meeting
  - Weekly
- Integration WIPT Lead Meeting
  - Daily
- Integration WIPT Meeting
  - Weekly
- Functional Lead Meeting
  - Weekly

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Project Documentation

- Systems Engineering Plan
- Product Performance Specification
- System/Subsystem Specification
- System/Subsystem Design Description
- Interface Control Document
- Initial Functional Analysis
- Test and Evaluation Strategy
- Test and Evaluation Program Plan
- System Requirements Verification Matrix

- Team Work Plan
- Configuration Management Plan
- Risk Management Plan
- Work Breakdown Structure
- System Safety Program Plan
- System/Subsystem Hazard Analysis
- Interim Support Plan
- User’s Logistics Support Summary
- Acquisition Logistics Support Plan
Document Traceability

NSWC Crane Allocated Baseline

NSWC Crane Product Baseline

NSWC Crane Functional Baseline

PMA-299 Functional Baseline

PMA-299 Product Baseline

Field / Fleet

Working Groups

TPWG
CSWG
SSWG

MH-60 Technical Data Package

FFFW Performance Specification

FFFW SSPP

FFFW ICD

FFFW SRVM

FFFW SSDD

FFFW TES

FFFW SRVM

FFFW SSDD

FFFW Technical Data Package

Legend

Requirements & Test Allocation

Interface Control

Implementation

Verification

System/Subsystem Hazard Analysis

Preliminary Hazard List / Assessment

Lessons Learned, Failure Data, etc.

Specifications, Regulations, Laws, Certification Requirements, etc.

System/Subsystem Hazard Analysis

Legend

Requirements & Test Allocation

Interface Control

Implementation

Verification

NSWC Crane Allocated Baseline

NSWC Crane Functional Baseline

NSWC Crane Product Baseline

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Design Environment

• Don’t Micro-Manage
  – Allowed the Leads to Lead
    • Helped Leads Identify Risks and Solutions
    • Didn’t ‘Trump’ Functional Lead Decisions
      – ‘Maybe sometimes’
  – Allowed Creativity
    • “My” Design would have looked vastly different
    • Is the system meeting requirements?
• Paperwork increased up the chain
The Line of Integration

• At what point do we draw the line for integration
  – COTS System onto Platform?
  – COTS Subsystems into a System onto Platform?
  – COTS Components into Subsystems into Systems onto Platforms?
  – The higher the better, within Performance, Schedule and Cost

• Use of Analysis of Alternatives and Trade Studies to identifying level of integration
  – Risk vs. Benefit Chart
    • This places the priority on the performance of the end item
  – Cost and Lead Time
    • Often COTS lead times are longer than entire project schedule
Key Documents

- System Subsystem Specification
  - Allocated Requirements to WBS Elements
  - Assigned to Functional Leads
- Interface Control Document
  - Defined External and Internal Functional, Physical, Human Interfaces
  - Established Interface Nomenclature
  - Assigned to Functional Leads
- System Subsystem Design Description
  - Established System Architecture
  - Documented System Wide Design Decisions
    - Quality Factors Allocation
    - Fire Controls Design Decisions
    - Power Subsystem Design Decisions
    - Weapons Ammunition Handling System Design Decisions
    - Aircraft Gun Mounting Adapter Design Decisions
  - Consolidated Trade Studies and Analyses to one Location
    - Alternative System Design Analysis
    - Gun Drive Motor Alternative Design Trade Study
    - Booster Motor Assembly Alternative Design Trade Study
    - M197 Assembly Alternative Design Trade Study
    - Firing Rate Selection and Vibration Analysis
    - System Faults Analysis
    - Hardware vs. Firmware Justification White Paper
    - Booster Motor Requirement Analysis
    - Dispersion/Boresight Analysis
System Architecture

20 MILLIMETER AUTOMATIC GUN HELICOPTER ARMAMENT SUBSYSTEM
A/A49E-27

FIRE CONTROL SUBSYSTEM 1A3
- Weapon Trigger (Cl) 1A3A2
- Gun Control Panel (Cl) 1A3A1
- Blank-Off Plate 1A3A3

WEAPONS AMMUNITION HANDLING SYSTEM 1A2
- Ammo Can (Cl) 1A2A2
- Booster Motor Assembly (Cl) 1A2A1
- Environmental Barrier Assembly (Cl) 1A2A5
- Feed Chute Assembly (Cl) 1A2A4
- Ammo Can Floor Adapter Plate (Cl) 1A2A3

POWER SUPPLY SUBASSEMBLY 1A4
- Power Subsystem (Cl) 1A4A1
- Wire Harness Subassembly (Cl) 1A4A2
  - 1A4A2-W1
  - 1A4A2-W6
  - 1A4A2A1
  - 1A4A2A2
  - 1A4A2-W3
  - 1A4A2-W5
  - 1A4A2-W6
  - 1A4A2-W4

AIRCRAFT GUN MOUNTING ADAPTER 1A1
- Gun Control Unit (Cl) 1A1A2
- Gun Mount (Cl) 1A1A1
- Gun Mount Wire Harnesses (Cl) 1A1A6
  - 1A1A6-W7
  - 1A1A6-W5
- Gun Drive Assembly (Cl) 1A1A3
- M197 Assembly (Cl) 1A1A4
- HLAID 1000P-W (Cl) 1A1A5

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NSWC Crane as the System Integrator

• RAPID RESPONSE
  – As a DoD Activity funding can be provided immediately avoiding contract lead times
  – This allows us to be fully engaged from the start of the program, working with the sponsor and end user to solidify requirements
  – No contract mods when requirements change
  – Flexibility to adjust to SE process changes
    • Drop non-value added tasks
    • Add emerging tasks to meet goals
Thank you for your time and attention!

For more information on NSWC Crane, please visit www.crane.navy.mil

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