Lockheed Martin Aeronautics Company
Approach to Solving Development Program Issues

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LM Aero Approach to Systemic Development Issues

- Industry Trend of Performance on Aircraft Development Programs
- What is in the Future
- What LM Aero is Doing
- Conclusions
DoD -- "Since 2004, total costs for a common set of 64 major weapon systems under development have grown in real terms by 4.9% per year -- costing $165 billion ($BY07) more in 2007 than planned for in 2004."

GAO 2007

AF -- 1.5 development cost growth ratio -- ongoing programs 5 yrs beyond M/S-B -- No improvement in 3 decades

RAND 2005
What is in the Future

• New Military Aircraft are Going to be More Complex.

• New Aircraft Development Spans are Monotonically Increasing.

• Our Future Workforce will be Less Experienced and More Inclined to Change Employers.
Aircraft Are Becoming More Complex

- C-5A
- F-16
- F-117
- C-17
- F-22
- F-35 (est.)

Lockheed Martin Aeronautics Company
Length of A/C Development Programs

Year span from Milestone A to Milestone C (JCIDS equivalents)
Typical Aerospace Company Age Profile

Median Age: Late 40’s

Relative Number of Employees

Most Technical Professionals Over 50 have Worked on 3 or More Aircraft Development Programs

Retirement Eligibility

Age
Root Causes for the Performance

• Poor Quality **Requirements** and Requirements Management Resulting in Designs that do not Fulfill Customer Expectations
  • Functional Baseline
  • Allocated Baseline
  • Active Management of Allocations

• Poor **Technical Planning** Prior to M/S B Resulting in Unrealistic Schedules and Unexecutable Plans
  • Level of Detail
  • Historical Bases for Spans
  • Linkage of Higher and Lower Level Planning to Key Integration Events
  • Interactively Versus Prescriptively Determined Key Program Event Dates
Root Causes for the Performance - Continued

• Limited **Experience** of Program Technical Personnel and Ineffective **Command Media**
  • New Inexperienced IPT Leads are Place in Critical Decision Making Roles without Adequate Help.
  • General, High Level Command Media is not Readily Useable by People Working on Development Programs

• Inability to Effectively and Objectively **Assess Technical Performance**, Quality and Integrity in a Timely Manner
  • Need for and Type of Corrective Action is Identified Too Late to Avoid Serious Consequences
  • Incomplete, Inconsistent and Inappropriate Metrics Incentivize the Wrong Actions

To Say “Poor Systems Engineering” Doesn’t Help
What Lockheed Martin Aeronautics is Doing

- Developing a Systematic Method to Define, with the Customer, Functional Baseline Requirements Much Earlier in the Acquisition Lifecycle

- Modeling the Aircraft Development Process in Sufficient Detail to Identify the Work Products, the Sequence in which they are Produced and the Work Product Handoffs

- Collecting the Best Practice Information for Creating Each Work Product and Making this Information Available to Those People Working on Development Programs.

- Instituting a Process to Independently Assess the Adequacy of Each Work Product Before it is Released and Defining Valid Metrics to Assess Real Performance in Every Area of the Program
Approach Applies to Pre-contract, Post-award Planning, and Program Execution

Proposal Submittal
- High level system design using a standard methodology
- Scope of work to be planned

Contract Award / ATP
- Lower – level details expanded for program execution
- Program Technical Plan & Program Work Products Standard

Program Baseline
- Technical data management function
- Gatekeeper role
- An independent source of performance metrics
- Data dissemination controls

High Level System Design
- Standard Tech Plan & WPS provides starting point
- Top – level definition applied to the specific program

Lower-Level System Design

System Design

Define Work Sequence & Output
- Technical Planning
- Work Products + Information

Refine Work Sequence & Output
- Technical Planning
- Work Products + Information

WP Review before Release
Air System Design – Late TD Phase

Reference Missions

Operational/Functional Requirements

Operational Environment Criteria

Deployment Environment

Support

Contractor Requirements

Analyze Missions
- Mission Decomposition
- Scenario Development
- Threat Description
- Stressing Requirements Development

Perform Air System Design
- Analyze & Decompose Requirements
- Functional Mech. & Timeline Analysis
- Perform Trade Studies
- Define Top-Level Architecture
- Verification Methods and Planning

Allocate Environmental Constraints

Derive Operational Constraints

Derive Support Constraints

Derive Self-Imposed Requirements

Define Tier 1, 2 Architecture
Allocate Perf. / Funct. Requirements
Plan Tier 1, 2 Verifications

TD Allocated Baseline Tier 1 & 2 Specification
TD Tier 1 & 2 Physical and Functional Descriptions

Requirements Not In The Contract

Technology Development Phase

SDD Contract Award

Air System Design – Late TD Phase

Lockheed Martin Aeronautics Company
A Functional Execution Model Establishes Effort Scope

Scope of Work
- Configuration
  - Hierarchy of Prime Equipment
- Air Vehicle
  - Airframe
    - Mission Sys
    - Vehicle Sys
- Logistics Sys

Supporting Developments
- Wind Tunnel
- Flight Test Control Room
- Autonomic Logistics

Air System Product/Service Tree

Standard Technical Development Framework
- Mission Systems Development
- Avionics Integration Laboratory Development
- Training System Development

Work Flow
Work Flow Captures Tasks, Sequence, and Work Products
Valuable Information to Provide with Every Standard Work Product

<table>
<thead>
<tr>
<th>WP Unique Name</th>
<th>Responsible IPT</th>
<th>Phase/Milestone</th>
<th>Reference Process (Command Media)</th>
<th>WP Template</th>
<th>WP Description</th>
<th>WP Maturity Required</th>
<th>Responsible Functional Organization</th>
<th>POC</th>
<th>Examples</th>
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Standard Plan Provides Sound Basis for Program Starting in Proposal Phase

LM Aero Standard Technical Plan

TOP LEVEL
Program-Customized Technical Development Framework
Basis for Proposal Schedule & Estimate

TOP LEVEL
Refined Technical Development Framework

SUPPORTING WORK FLOWS
Program Customized Execution Level Details

Proposal Submittal
Contract Award / ATP
Program Baseline

Program Executes to Integrated Master Schedule & EVMS
Technical Integrity in the Release Process

IPT Creates Work Product

Chief Engineer’s Office Adjudicates Differences

Consumers Evaluate Work Products

Work Product Adequate?

No

Yes

Work Product Released and Cataloged

Work Products Available to Users

Start

- Evaluation Checklist
- WP Maturity Criteria
- Templates
In Order to Remedy Many of the Problems with Development Programs, the Necessary Top Level Design and Planning Must be Done Before M/S B.

In Order to Function with Tomorrow’s Workforce in Tomorrow’s Development Environment, Our Industry Should Take a Lesson from the Commercial World and Make Our Development Business More Turn Key.

- Standard Planning Templates
- Command Media That Define The Best Practice for Generating the Work Product