

Lean Aerospace Initiative Implementing Lean PD Workshop

*Best Life Cycle Value,
the F/A-18E/F, and
the Lean Enterprise Model*



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- **Best Life Cycle Value Case Studies**
 - Research review
 - Progress report
 - Future work
- **PRELIMINARY findings**
 - Mapping the F/A-18E/F practices to the Lean Enterprise Model (LEM)



Best Lifecycle Value Case Studies

Research Team:

Alexis Stanke	LAI - PD
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- **Best life cycle value is a LAI Phase III research focus**

Two Primary Issues:

- **Characterization**
 - **How is best life cycle value defined for different systems?**
- **Achievement**
 - **What enabling practices and metrics contribute to achieving best life cycle value, however it is defined?**

**Capture enabling practices for future programs.
Codify knowledge for implementation and training.**



Key Questions

- **How is best life cycle value defined and achieved by different programs?**
 - What are the dimensions and metrics of best life cycle value?
 - In what phases of the program is best life cycle value most effectively addressed?
 - What are important enabling practices and metrics for achieving best life cycle value?
 - What are the barriers to improving best life cycle value in future systems?
- **Is there a common best life cycle value framework across different programs?**
- **How are enabling practices for achieving best life cycle value related to the LEM?**



- **Develop and test a common research methodology**
 - **Structured survey interview format**
 - **Qualitative and quantitative data collection**
- **Conduct case studies**
 - **F/A-18E/F Super Hornet (LAI)**
 - **JAS 39 Gripen (LARP)**
 - **777 (LAI)**
 - **JPATS (LAI)**
 - **Others TBD**
- **Relate case study data to LEM**
- **Develop common life cycle value framework**
- **Vet findings**
- **Produce research products**



✓ June - Aug. 00

- Test and refine research approach
- Conduct F/A-18E/F field work (LAI)

● Sept. - Nov. 00

- Conduct JAS 39 Gripen field work (LARP)
- Develop conceptual framework for best life cycle value
- Write joint LAI and LARP paper

● Nov. 00 - Jan. 01

- 777 and JPATS field work (LAI)
- Methods research with F/A-18E/F EFF program on product development processes for improving life cycle value

● Feb. - Mar. 01

- Update framework with additional case study data
- Prepare draft products for review

● Apr. - May 01

- Complete research and products



Candidate Framework for Life Cycle Value

Value Identification

- Identify Stakeholders
- Understand each stakeholder's value system
- Establish stakeholder expectations

Value Proposition

- Create stakeholder alignment
- Balance stakeholder expectations
- Establish clear communication of balanced expectations with all stakeholders

Value Delivery

- Create product that meets balanced expectations outlined in the value proposition and retains these qualities throughout its life



PRELIMINARY Findings

Mapping the F/A-18E/F Practices to the Lean Enterprise Model (LEM)



F/A-18E/F Overview

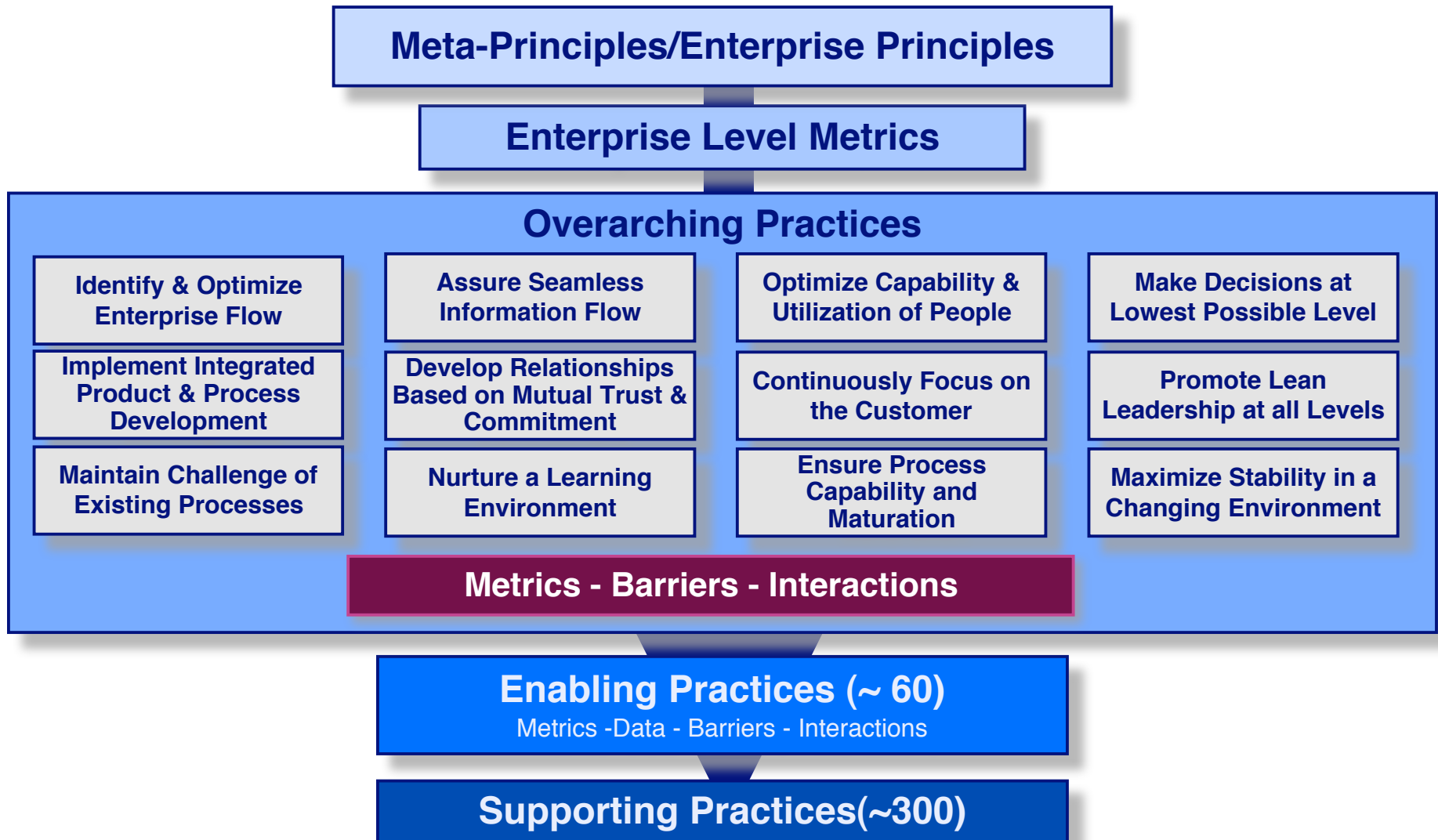
- **Upgraded version of F/A-18C/D**
 - 25% larger aircraft and payload
 - 40% increase in unrefueled range
 - 3 times greater “bring back” ordnance
 - 5 times more survivable
 - Equal reliability and maintainability
 - Similar avionics
- **Development costs capped at \$4.88B**
- **8.5 years from “go ahead” to IOC**
- **F/A-18E/F Enterprise**
 - Core: NAVAIR, Boeing, Northrop Grumman, Raytheon, GE
 - Extended: Over 2500 suppliers



Scope of F/A-18E/F Study

- **Concentration on Product Development and Acquisition**
 - Data collection included interfaces with suppliers, production, logistics, product and business support, and program management
 - Secondary sources included production
- **Over 80 people from 3 organizations interviewed**
 - NAVAIR - Navy Program Office
 - Boeing, St. Louis - Prime Contractor
 - Northrop Grumman, El Segundo - Principal Sub-Contractor
- **Attended program meetings**
- **Collected program documentation**
- **Lived the program culture during the site visits**
- **Fall 00 study of 18 month “gap” remains (LARA)**

Lean Enterprise Model Overview



F/A-18E/F a Lean Enterprise ?

- Mapped observed F/A-18 E/F program practices to LEM Enterprise Principles, Overarching and Enabling Practices
- Management strategies of the F/A-18E/F program align well with LEM principles and practices
- Success of the Super Hornet in achieving program goals supports the credibility of the LEM framework

Preliminary Conclusion:

Based on the structure outlined in the LEM, the Super Hornet is an example of an evolving *Lean Enterprise*.



Enterprise Principles

- **Right Thing at the Right Place, the Right Time, and in the Right Quantity**
 - **Weapon system which meets and exceeds 1) technical requirements, 2) cost, and 3) schedule goals**
 - **F/A-18E/F changed the perspective that achieving 2 out of 3 was good enough**
 - **Program goals set at the contract award in 1992 were met**
 - **Philosophy that the “airplane is the boss” when trades are made**
- **Effective Relationships within the Value Stream**
 - **Establish and maintain program credibility**
 - **Hornet Industry Team**
 - **Culture change within the organizations involved with the 18 Aircraft Agreement**



Enterprise Principles cont.

- **Continuous Improvement**

- Numerous program management practices introduced
 - Created strategies and practices that can be institutionalized and adhered to
- Program trades were made with a long-term view of the path ahead instead of looking for short-term rewards
- Early success of the program has set high expectations for future phases

- **Optimal First Delivered Unit Quality**

- OPEVAL report released in Feb. 00 with a rating of “operationally effective and suitable”
- Sea Worthiness trial performance



1: *Identify and Optimize Enterprise Flow*

“Optimize the flow of products and services, either affecting or within the process, from concept design through point of use.”

- **Collocation of product and people**
- **Alignment of organizational structure to the product work breakdown structure**
- **Common CAD modeling software used across the enterprise**
- **Low Rate Expandable Tooling (LRET) minimized number of jigs and movements**
- **Work content in production areas is reorganized to prevent bottlenecks**



2: *Assure Seamless Information Flow*

“Provide processes for seamless and timely transfer of and access to pertinent information.”

- **Open and honest communication**
 - Ask for help needed
- **Internet technology and company web sites enable sharing data and information within the enterprise**
 - Access to data is timely and efficient
 - Databases are linked throughout the value chain
- **Metrics shared weekly throughout the enterprise**
- **“Drop Dead” philosophy**
 - Documenting your job so that someone could come in the next day and pick it up where you left off



3: Optimize Capability and Utilization of People

“Assure properly trained people are available when needed.”

- **Using a production gap as an opportunity for career and skill development programs**
- **IPT structure broadened functional responsibilities to facilitate the development of a flexible workforce**
- **Choose the best person to solve the problem, regardless of which part of the enterprise they are from**



4: Make Decisions at Lowest Possible Level

“Design the organizational structure and management systems to accelerate and enhance decision making at the point of knowledge, application, and need.”

- **Organization chart was aligned with the product work breakdown structure to establish multi-disciplinary teams**
- **Joint Configuration Change Board (JCCB) is an example of how responsibility for decisions is shared throughout the value chain and how well-defined processes expedite this decision process**
- **People are empowered to make decisions through the flow down of requirements and metrics creating Responsibility, Authority, and Accountability (RAA)**



5: Implement Integrated Product and Process Development

“Create products through an integrated team effort of people and organizations which are knowledgeable of and responsible for all phases of the product’s life cycle from concept definition through development, production, deployment, operations and support, and final disposal.”

- **Systems engineering practices were used in product design**
- **Requirements were established and flowed down to the responsible teams (RAA)**
- **Risk management process is structured and shared throughout the enterprise**
- **Design for manufacturing and assembly led to 42% reduction of part count over C/D**
 - **Low Rate Expandable Tooling (LRET) design and Variation Simulation Analysis (VSA)**



5: Implement Integrated Product and Process Development cont.

“Create products through an integrated team effort of people and organizations which are knowledgeable of and responsible for all phases of the product’s life cycle from concept definition through development, production, deployment, operations and support, and final disposal.”

- **The capability for growth and adaptability was designed in and continues to improve through the Enhanced Forward Fuselage (EFF) redesign**
- **Many stakeholders were involved in pre-contract planning**
- **Earned Value tracking of cost and schedule metrics incorporated through the “perform to plan” philosophy**



6: Develop Relationships Based on Mutual Trust and Commitment

“Establish stable and on-going cooperative relationships within the extended enterprise, encompassing both customers and suppliers.”

- **Program leadership emphasis on maintaining credibility**
- **Leadership brings people together and facilitates working together by preventing strong personalities from taking over**
- **Labor-management partnerships are established through High Performance Work Organizations (HPWO) where issues can be worked by a team regardless of affiliation**
- **Many functions were involved in the program definition process early and given an equal voice to establish common objectives and cooperative relationships**



7: Continuously Focus on the Customer

“Proactively understand and respond to the needs of the internal and external customers.”

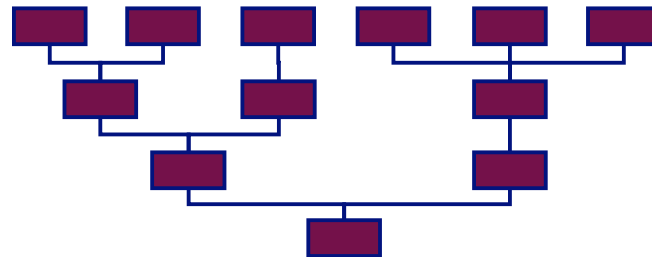
- **Award fee periods each had unique criteria which were understood at the beginning of each period to optimize the flexibility of the contract to changing requirements**
- **Enterprise stakeholders worked effectively to resolve issues found during test - Integrated Test Team**
 - **Wing drop issue and solution**
- **Contractors supported customer’s requirements definition process**
- **Organizational counterparts throughout the enterprise with active working relationships**



8: Promote Lean Leadership at All Levels

“Align and involve all stakeholders to achieve the enterprise’s lean vision.”

- Leadership alignment across enterprise
- Management support mentality - turn the organization chart upside down



- Program management training
 - Boeing Program Management Best Practices
 - Integrated command media to describe IPT processes
- Activities to implement lean practices in the production areas



9: Maintain Challenges of Existing Processes

“Ensure a culture and systems that use quantitative measurement and analysis to continuously improve processes.”

- **Cost Reduction Initiative (CRI) structure is a way to generate, evaluate, and implement improvements**
- **Risk management process includes mitigation plans to fix problems systematically using root cause analysis**
- **Jointly established targets for continuous improvement are included on the 2030 roadmap, generated by the Hornet Roadmap Team using a structured QFD process**
- **Management pushed to evaluate the alternative no growth (in cost or weight) solution in terms of risk**



10: Nurture a Learning Environment

“Provide for the development and growth of both organizations’ and individuals’ support of attaining lean enterprise goals.”

- **Lessons learned databases are used to capture, communicate, and apply experience generated learning**
 - **Over 900 lessons learned from the A/B and C/D models were incorporated in the E/F version**
- **Some benchmarking was done early in the program**
- **Knowledge is utilized throughout the enterprise regardless of where it originates**



11: *Ensure Process Capability and Maturity*

“Establish and maintain processes capable of consistently designing and producing the key characteristics of the product or service.”

- **Common databases, tools, and practices have been defined throughout the value chain**
- **Enhanced Forward Fuselage (EFF) project is a large scale example of exploiting process maturation for cost benefit**
- **Process capability and maturity leveraged with other programs**



12: Maximize Stability in a Changing Environment

“Establish strategies to maintain program stability in a changing customer driven environment.”

- **Program was never rebaselined**
- **Multi-year contract signed June 2000**
- **“Perform to Plan” philosophy led directly to the notable schedule performance of the program**
- **Maintained stable workforce capability over an 18 month production gap**
- **Program was structured to absorb changes with minimal impact by using a Block upgrade strategy**
- **State of the art technology was properly judged, facilitating programming high risk developments off critical paths**



- **High correlation between F/A-18E/F observed practices and the LEM Overarching and Enabling Practices**
 - **Additional enabling practices observed**
 - **Additional LAI and LARA findings to be included**
- **Practices extended and shared throughout the 3 observed organizations in the Super Hornet Enterprise**
- **F/A-18E/F achieved or exceeded all program goals**

Preliminary Conclusion:

Based on the structure outlined in the LEM, the Super Hornet is an example of an evolving *Lean Enterprise*.

And the journey continues . . .



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