Growing the Lean Community
An LAI Plenary Conference

Organizing for Subsystem Commonality
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MIT

Research Sponsored by LAI
➢ Study A overview and findings
  ➢ Organizational structures
➢ Study B overview and findings
  ➢ Organizational processes and policies
➢ Potential policy implications
Study A Background

- Matt Nuffort (TPP ‘00)—thesis available on LAI web site

- Research questions (relating to organizing for subsystem commonality)
  - How should the government be organized to support increased use of common subsystems?
  - How should contractors and suppliers be organized to utilize subsystem commonality, and what incentives do they need to do so?

- 8 primary case studies with background from 7 additional system SPOs
  - 84 people interviewed
  - Extensive follow-up documentation collected
Review: Benefits and Challenges with Commonality

**Benefits:**
- Significant savings in acquisition and annual O&S costs of subsystem
- Commonality reduces cycle time and increases warfighter reliability, availability, and efficiency

**Challenges:**
- Different missions require novel solutions/higher performance
- Funding
  - Staggered acquisitions, annual budgeting discourages investment with future payoffs, no money to change architecture on legacy platforms
  - Lack of accurate LCC tools for commonality cost justification
- Organizational Issues
  - “Silo” organizations
  - Commonality increases coordination/cooperation requirements
  - How is configuration managed and who does it?
  - Desire for multiple suppliers
Observation from study: a common organization managing multiple platforms/subsystems can overcome many of the challenges cited to provide benefits

- Cross-platform perspective
- Requirements mediator
- Technical support
- Configuration management
- Product family strategy
- Industry awareness

Challenges to a common organization

- Overhead associated with maintaining a dedicated subsystem organization
- Gaining trust of platform/system SPOs
- Lack of accurate LCC tools
One Model: Managing Commonality “Upstream”

- Prime integrators manage commonality
  - Responsive to customers’ differing requirements
  - Potential support responsibility motivates search for commonality
  - Manage platforms and derivatives in own product portfolio
    - Maintain platform-specific expertise
    - Develop infrastructure for sustainment
- Key suppliers manage commonality
  - Develop families of subsystems
  - Focus on modular and open architectures for system sustainability
    - “Open up” boxes to develop markets for SRUs to balance customizability with supportability and logistics
Issues in Managing Commonality “Upstream”

➢ Mission performance imperative drives unique solutions
  ➢ “Voice of customer” reduces commonality when there are multiple customers
➢ Few incentives for commonality from customer
  ➢ Focus of acquisition decision is largely on acquisition cost
  ➢ Lack of LCC tools make it difficult to quantify lifecycle benefits in order to justify up-front expenses
  ➢ Individual program managers reluctant to drive up cost, schedule, and risk to primarily benefit another program
➢ Even after industry mergers, no one upstream supplier “owns” the entire deployed force
  ➢ Parallel logistics streams, multiple standards, increased support complexity
Another Model: Managing Commonality “Downstream”

- Common SPO or Centers of Excellence in subsystems
  - e.g., GATM, Common Avionics SPO, PMA 209 (Common Aircrew Systems)

- Concentrate domain expertise in one location
  - Market knowledge
  - System architecture/technical knowledge

- Serve as nucleus and champion for efforts to define open standards

- Develop product family strategies and “catalogs” of compatible product offerings
  - Manage for support and technology obsolescence
Issues for Downstream Management Model

➢ Requires coordination and mediation of multiple platforms’ requirements
  ➢ Buy-in of platform SPOs a challenge

➢ System lifecycle ownership/management distributed across service organizational structure
  ➢ AFMC owns ALCs
    ➢ Provides whole Air Force perspective cradle to grave
  ➢ MAJCOMs own the missions
    ➢ Pay for O&S
    ➢ MAJCOMs cluster similar missions/platforms together
    ➢ Focus on platforms that deploy together

➢ Increases “overhead” associated with subsystem management in the short term
➢ Common organization managing portfolio of subsystems can work and produce benefits
  ➢ But, upstream or downstream responsibility?
➢ Creating common subsystem organizations (government and industry) go against the grain of established functional/mission-oriented institutions
➢ Dilemma: how to organize and manage so that the benefits of commonality become more widespread across the organization?
Study B Background

➢ Michelle Beckert (SDM ‘00)—thesis available on LAI web site

➢ Strategy: use strategic, political, and cultural perspectives to analyze the challenges in organizing for product line engineering (PLE)

  ➢ Strategic: What organizational structure, processes, and metrics best facilitate product line engineering so that the potential benefits associated with this approach may be achieved

  ➢ Political: What role does senior management need to play in a product line engineering organization? Who is responsible for maintaining alignment among the platform and the derivative products?

  ➢ Cultural: How does organizational communication facilitate product line engineering? What types of training do product line engineering organizations utilize?

➢ 4 case studies covering 65 projects

  ➢ Turbine power systems; Printing systems; Avionics systems; Engine accessories

➢ Data provided through interviews and documentation
Building PLE Capability

Cultural characteristics inform and guide the behaviors that fulfill the strategic direction.

Political characteristics provide “traction” for the strategic direction within the organization.

Strategic characteristics provide the foundation and operating context for successful PLE efforts.
## Firm Performance

<table>
<thead>
<tr>
<th>Organizational Data</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Implementing PLE (years)</td>
<td>10+</td>
<td>4</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10</td>
</tr>
<tr>
<td>Market Share (%)</td>
<td>75&lt;sup&gt;b&lt;/sup&gt;</td>
<td>94&lt;sup&gt;c&lt;/sup&gt;</td>
<td>60&lt;sup&gt;b&lt;/sup&gt;</td>
<td>55</td>
</tr>
<tr>
<td>Overall Size (no. of people)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5500</td>
<td>2000</td>
<td>1300</td>
<td>5000</td>
</tr>
<tr>
<td>Number of Platforms</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Number of Derivatives</td>
<td>12</td>
<td>9&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>PLE Ratio (Derivatives/Platforms)</td>
<td>2.4</td>
<td>1.5</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>PLE Cycle Time Ratio (Derivative Cycle</td>
<td>0.25</td>
<td>0.5</td>
<td>0.35&lt;sup&gt;f&lt;/sup&gt;</td>
<td>0.24</td>
</tr>
<tr>
<td>Time/Platform Cycle Time)</td>
<td></td>
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</tbody>
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- Firms A and D have relatively more mature PLE capabilities
  - Greater number of derivatives per platform
  - Shorter product cycle times through derivatives
Strategic Characteristics

➢ Goals and metrics:

➢ Strategic plans clearly defined goals relating to the development of platforms and/or product lines

➢ Metrics used that apply specifically to product line engineering

➢ Amount of technology sharing

➢ Extent to which a product meets established coherence requirements

➢ Number of derivative products a platform can generate

➢ Amount of unique part numbers

➢ Organization-wide coherence requirements reinforce platform and product line strategy
Strategic Characteristics, cont.

➢ Strategies:
  ➢ Product line engineering strategies implemented uniformly across organization (e.g., “zero tolerance policy”)
  ➢ Smallest percentage of projects use new design strategy
  ➢ Over half of projects leveraged product development through concurrent technology transfer (a defined strategy for knowledge transfer from one project to another overlapping project)

➢ Resource and technology sharing:
  ➢ Resources organized around platforms to dictate resource and technology sharing
  ➢ Individuals designated to recognize and act upon opportunities for organizational sharing
  ➢ Modular system architectures to facilitate sharing
  ➢ Initiatives to standardize components and parts to increase technology sharing
Political Characteristics

➢ Management and Stakeholders:
   ➢ Senior management defines and enforces product line strategies (not a “grass roots” movement)
   ➢ Supplier stakeholders have “buy-in” to platform strategy through risk-sharing partnerships
   ➢ P&L responsibility at a level where decisions can be made at the portfolio level

➢ Responsibility and accountability:
   ➢ Responsibility for maintaining platform and derivative alignment held at a high level in the organization
   ➢ Change control boards comprising platform team members control platform architectures
➢ Communication and training:

➢ Communication modes defined specifically to convey product line engineering strategies

➢ Communication modes designed to facilitate resource and technology sharing

➢ New employee orientation covers general product standards and specific product lines of the organization
Observations consistent with previous LAI research on managing the front end of product development
Policy Implications

➢ System/mission requirements are diverse at the platform level, consistent at the functional level (e.g., sensing, identification, communication, etc.)
   ➢ Implication: subsystem rather than system focus for commonality

➢ System lifecycle behavior defines leverage points
   ➢ Individual systems operate, deploy, and sustain in “packages” comprising multiple platforms and organizations
   ➢ Inventory in the sustainment “pipeline” is non-trivial
   ➢ Implication: Unit of focus for commonality is more likely within-service, rather than joint
System (e.g., product) characteristics determine focus

➢ Commercial examples are frequently “closed systems”—define architecture, organize hierarchically, and delegate responsibility

➢ Military examples are frequently “open systems”—customer drives system behavior through requirements and acquisition processes and incentives

➢ Implication: customer (e.g., requirer) plays a defining role in reaping the benefits of commonality

➢ High-level support required to make binding decisions across multiple platforms

➢ Implication: need organic analytical capability to support senior decision-makers

➢ Incentives for/against commonality must be addressed by all stakeholders across the enterprise

➢ Does funding naturally flow toward common or unique solutions?