Research Overview: 
Fostering Innovation Across Aerospace Supplier Networks

“Value Creation Through Integration”
LAI Workshop, Fort Worth, TX
Jan 31, 2002

Presented By:
Aaron Kirtley
Candidate for S.M. in Mechanical Engineering and Technology & Policy

Thesis Supervisors: Dr. Kirk Bozdogan
Reader: Dr. Daniel Whitney
Lean Aerospace Initiative

Key Research Question

- Thinking beyond traditional factory floor “lean”
- Recognizing the supply chain as part of the extended enterprise
- Realizing the high potential for technological innovation at the customer-supplier interface

What incentives, practices, and tools can aerospace companies employ to stimulate innovation across their supply base?

Exploring...
- Methods to foster supplier-based product and process innovations to reduce production cost, improve performance, and mitigate parts obsolescence problems
- Innovative business models and integration strategies to continuously incentivize and tap these innovations to optimize lifecycle affordability
- Barriers to the flow of innovation and ways to overcome them
Avionics systems represent special challenges in ensuring the performance, continuous mission capability and lifecycle affordability of military aircraft.

Increasing technological sophistication & complexity; rising share of total lifecycle cost of ownership:

- Fast-clockspeed technology environment
- Huge potential for parts obsolescence problem

Program transitioning into production phase, featuring both cutting-edge technology and increasing emphasis on cost reduction:

- Suppliers account for much of the technology & cost

Effective supply chain integration critical to meeting both affordability and performance objectives.
Methods to improve communication and information exchange

- Leading to flow of ideas across supply chain, better understanding of customer’s needs, greater trust
- Include practices such as IPTs, collocation of engineers, IT infrastructure, technology “gatekeepers”, supplier associations

Risk sharing, joint funding of investments and improvement projects

Creative contractual agreements and incentive structures

- Long-term contracts, target costing, sharing of cost savings

Supplier training, support, and knowledge-sharing
Potential Drivers & Enablers of Supplier Innovation

- Sourcing strategies; appropriate levels of competition
- Collaborative research and development
- Early integration of suppliers into design and development
- System architecture designs that enable on-going and rapid integration of new technologies and minimize obsolescence
Concentrated on supplier network supporting the F-22 avionics system and its various subsystems

Conducted structured interviews with wide range of key personnel involved in the program, at prime contractor, major supplier and sub-tier organizations (~50 people)

Performed focused case studies examining selected avionics subsystems to gain more detailed understanding of specific issues and questions

Lockheed Martin

Aerospace Technology Corporation (radar)

BAE SYSTEMS (EW suite)

Four of key ATC sub-tier suppliers

Four of key BAE sub-tier suppliers
Features of Innovation Observed

➤ “Specified” Innovation - driven by extremely ambitious performance requirements and tight design margins flowed down supply chain

➤ Highly integrated system -→ tends to restrict supplier flexibility in design, limit latitude for innovation

➤ Understanding and coordinating activities across the extended supply chain very important

Organizational Supply Chain for Syntactic Foam

- Lockheed Martin
- BAE SYSTEMS
- Supplier X
- Chemical Supplier
Features of Innovation Observed

➢ Greatest potential for innovation lies in initial design phase -> early involvement of suppliers essential
  • Requalification requirements present major barrier to later innovation

➢ Innovation often involves streamlining or eliminating unnecessary performance and testing requirements; this means customer, prime, major suppliers & sub-tiers must work together
  • Requirements and testing tend to be over-prescribed initially due to uncertainty about performance & integration
In light of limited resources, relationship approach must fit strategic importance of supplier

- Streamline supply chain, identify *preferred* suppliers

<table>
<thead>
<tr>
<th>Supplier dependence on customer</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
</table>
| **Low** | - arms-length relationship  
- minimal investment | | 
| **High** | - supplier has good understanding of customer’s product, goals, & needs  
- invest in supplier but avoid over-commitment, maintain a few additional sources | 
| **DIFFICULT SOURCING SITUATION!**  
- establish clear & calculable rewards for innovation  
- consider producing item in-house, developing other sources  
- standardize design to increase number of potential suppliers | - close partnership  
- shared investment, training  
- frequent communication  
- supplier has good understanding of customer’s product, goals  
- good understanding of supplier’s capabilities |
Case studies show good two-way communication is key to fostering supplier innovation

- Essential to coordinating changes, integration of complex systems
- Hold regular cost reviews & brainstorming sessions with top suppliers; periodically re-evaluate requirements and proposed solutions
- Create IT infrastructure to improve system integration, provide up-to-date notification of change decisions, and increase visibility of the value stream

“There is more interest in collaboration than ever before, yet fewer resources for doing so.”
Communication may exhibit “hub-and-spoke” pattern

- Restricts information exchange between suppliers

Customer/military concern for secrecy often limits communication, supplier’s ability to understand customer’s needs
Findings and Recommendations -
Shared Investments, Risk

➤ Major suppliers reduce investment in new technologies because of program uncertainty & limited internal resources
  • Tough business case for individual programs; spillover benefits across programs go unrecognized
  • Companies avoid internal investments with long payoff periods; neglect training & hiring of top-notch talent

➤ Also, case studies show sharing of investment cost and risk with suppliers seems to occur rarely in defense aerospace context

➤ Major suppliers keep looking for new suppliers (large switching & transaction cost) rather than making long-term investments in key suppliers

➤ War on Cost, PIP funding is a step in right direction by government, but appears very limited given the scope of the problem
  • Many ideas cost saving provided by suppliers but reportedly few are funded
Identify & take advantage of specific opportunities for sharing in supplier investments -- new processes and equipment, product redesign, joint R&D

- Lower tier suppliers are often capital resource constrained and/or unwilling to bear “asset-specific” investment risk alone

- Customer company should be aware of conditions in which investment sharing makes sense
  - Ability to observe and share in savings realized by supplier
  - Positive NPV, rate of return justifies customer’s use of funds
  - How does the investment fit into suppliers overall business structure (specific to the relationship or general to suppliers business?)
  - Size, financial capacity of supplier
Findings and Recommendations - Contractual Incentives

➢ Contract structure and incentives have major impact on suppliers’ motivation/willingness to innovate

➢ Lean practices of target costing or profit sharing rarely used

➢ Much of government’s contracting approach with prime is mirrored in contracts with lower-tiers; sets tone for how prime manages its supplier relationships

➢ Currently, avoiding program cancellation is the only incentive for supplier innovation; in some cases companies have negative incentive to improve
Findings and Recommendations - Contractual Incentives

➢ Develop more creative incentive mechanisms, particularly at lower tiers
  • Use multi-year contracts, price-commitment curves
  • Avoid highly specialized, sole-source designs
  • Avoid concurrency in design and production-- constant stream of design changes has large cost & schedule impact especially on lower tiers
  • Non-monetary rewards such as recognition and awards can provide motivation for suppliers to perform and increase goodwill and trust
Training can be effective but not always necessary

- Important for suppliers to have “lean champions”, who understand both lean principles and industry/company context
- Some suppliers already “leaner” than major contractors

Identify new technology directions and share with supplier community

Seek opportunities for commonality across platforms to leverage innovations on newer designs on older programs
A large portion of past key technological breakthroughs applicable to military fighter aircraft represent a result of government-supported research

- e.g. Mantech support to improve radar manifold

DoD can play central role by subsidizing research to spur innovation in critical defense technologies

- Suppliers often lack adequate incentives to innovate because potential for rewards too low
- Scaled-back R&D by major suppliers has reportedly resulted in less technology transfer to lower tiers
- Helps to prevent “innovation-gap” between programs--fewer programs, long-time between them
Government’s Role in Spurring Supplier Innovation

➢ Financial weakness of lower tier suppliers often exacerbated by government contracting practices
   • Long payment terms strain resources

➢ Reduction in red-tape and oversight has occurred and been helpful, but more could be done

➢ Process for obtaining government funding support for research/investment projects reportedly too complicated, lengthy

➢ Agreement on uniform, streamlined set of specifications for industry would improve ability of suppliers to incorporate new technology into designs
Conclusions

➤ Focus on ways to increase communication throughout entire supplier network

➤ Take advantage of opportunities to support suppliers through shared (joint) investments

➤ Increase incentive provisions in contracts and reduce program uncertainty to maximum extent possible

➤ Train suppliers where appropriate

➤ Provide suppliers insight into future technology needs/roadmaps; government should subsidize research in defense-critical areas as well as modification of commercial technologies to meet military performance requirements