Supply Chain Ecosystem

for

Urban Air Mobility

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Scalability is Fundamental Need for UAM

• Many pilots (or acceptable and reliable autonomy)
• Spectrum availability
• Airspace operations (e.g., Unmanned Aircraft System Traffic Management type construct)
• Acceptable noise
• Mass production of electric or hybrid VTOLs
• Infrastructure (including recharging systems)
Mass Production of VTOL Vehicles

• Production rates need to be closer to cars than conventional aircraft
  
  • Manufacturing and assembly methods

  • Supply chain network and ecosystem
Supply Chain: Basics

- Supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer need.
- Aerospace supply chain is an ecosystem of different supplier tiers.
- Includes manufacturers, suppliers, transporters, warehouses, etc.
- Supply chain management refers to coordination of all supply chain activities starting with raw materials and ending with a satisfied customer.
  - Purpose: Maximize competitive advantage and benefit customer.
Current State of the Art in Aero Supply Chain

- Boeing and Airbus have backorders (~5000+, with ~55/month rate)
  - Boeing delivered 806 aircraft and Airbus 800 in 2018
  - In 2016, Boeing had 5715 undelivered orders and Airbus had 6874

![Forecasted production levels of commercial aircraft: 2016 to 2034](image-url)

Source: Deloitte analysis, Airbus, Boeing
Current State of the Art

• Presidential executive order on assessing and strengthening the manufacturing and defense industrial base and supply chain resiliency of the United States (executive order 13806, September 2018)

  • Decline of U.S. manufacturing capabilities and capacities

  • Competitiveness

  • Diminishing STEM and trade skills
Current State of the Art

• Risk Archetypes
  • Limited/sole sources
  • Fragile supplier and market
  • Capacity constrained supply market
  • Foreign dependency
  • Diminishing manufacturing sources and material shortages
  • Gap in U.S. human capital
  • Product security
Supply Chain Strategies

• Many suppliers
• Few suppliers
• Vertical Integration
• Joint Ventures
• Horizontal Integration
• Keiretsu Networks (part collaboration, part few suppliers, part vertical integration)
• Virtual Companies
<table>
<thead>
<tr>
<th>Tier 1</th>
<th>Tier 2</th>
<th>Tier 3</th>
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<tbody>
<tr>
<td>Engine</td>
<td>Mechanical Parts</td>
<td>Accessories</td>
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<tr>
<td>Landing Gear</td>
<td>Wheels &amp; Brakes</td>
<td>Bearings</td>
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<tr>
<td>Wings</td>
<td>Flight Control Actuators</td>
<td>Plastic Parts &amp; Castings</td>
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<tr>
<td>Fuselage</td>
<td>Avionics &amp; Hydraulics</td>
<td>Interior &amp; In-Flight Entertainment</td>
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- **OEM** – Control design, manufacturing and assembly function, the most critical component of value chain
- **Tier 1** – Support Primes by providing them with equipments and systems like engines, Wings, Fuselage
- **Tier 2** – Manufacture and develop parts as per the specifications provided by primes and Tier 1 suppliers
- **Tier 3** – Responsible for supplying basic products, components and other non-core value added services

Known Aero Supply Chain Related Issues

• Sourcing of raw materials – aluminum, steel, copper, etc.

• Mitigating supply disruption risks (e.g., geopolitical considerations)

• Coping with Modernization and Emerging Technologies (e.g., wiring problems, software issues)

• Shortage of skilled workers (Tim Cook’s view on outsourcing)
Supply Chain Considerations and Challenges
(Credit: EY – A&D Edge, Supply Chain Management in Aerospace and Defense, Feb 2018, slides 8-9)

<table>
<thead>
<tr>
<th>Design and Engineering</th>
<th>Planning</th>
<th>Procurement</th>
<th>Manufacturing</th>
<th>Aftermarket</th>
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<tr>
<td>Considerations</td>
<td>Design and Engineering</td>
<td>Planning</td>
<td>Procurement</td>
<td>Manufacturing</td>
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<tr>
<td>• Timeline</td>
<td>• Forecast accuracy</td>
<td>• Supplier performance</td>
<td>• Quality</td>
<td>• Ground time</td>
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<tr>
<td>• Cost</td>
<td>• Supply disruptions</td>
<td>• Price volatility</td>
<td>• Stock-outs</td>
<td>• On-time delivery</td>
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<tr>
<td>• Quality</td>
<td>• Demand shifts</td>
<td>• Cost and prices</td>
<td>• Waste</td>
<td>• Network</td>
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<tr>
<td>• Margin</td>
<td>• Inventory</td>
<td>• Lead times</td>
<td>• Capacity</td>
<td>• Safety</td>
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<td>• IP</td>
<td>• Supply chain visibility</td>
<td>• Supplier due diligence</td>
<td>• Cost</td>
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<tr>
<td>• Efficiency</td>
<td>• Lead times</td>
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<td>• Contract</td>
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Challenges
• Dependence on large number of sole-source suppliers
• Long lead time
• Financial challenges across the supply chain for new programs
• Large inventory needs
• Collaboration across complex supply chain
• Cyber and security
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<tr>
<th>Strategy</th>
<th>Dependence on sole source suppliers</th>
<th>Long lead time</th>
<th>Financial challenges</th>
<th>Large inventory</th>
<th>Collaboration across supply chain</th>
<th>Cyber threats</th>
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<tbody>
<tr>
<td>Adoption of digital technologies</td>
<td>Moderate</td>
<td>High</td>
<td>Low</td>
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<td>Risks-sharing partnerships</td>
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<td>Integration</td>
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<td>High</td>
<td>Moderate</td>
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<td>Moderate</td>
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<td>Monitor security</td>
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<td>Moderate</td>
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<td>Cross-sourcing</td>
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<td>High</td>
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<td>Multiple sourcing</td>
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<td>Readiness assessment</td>
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<td>Local players in supply network</td>
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<td>Moderate</td>
<td>Low</td>
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Credit: EY – A&D Edge, Supply Chain Management in Aerospace and Defense, Feb 2018)
Recommendations: Supply Chain for Urban Air Mobility Vehicles (Drones and VTOLs)

• Time to start building an entire new eco-system
• Take advantage of other manufacturing (e.g., auto)
• Rebuild/train auto, heavy industries, traditional aerospace suppliers to consider VTOL
• Get regional manufacturing and supply chain associations exposed to emerging aero needs
Recommendations: Supply Chain for Urban Air Mobility Vehicles (*Drones and VTOLs*)

- Build an electronic exchange platform to connect VTOL customers with suppliers
  - Prototypes
  - Job production
  - Mass production
  - Quality management based on FAA production need
- Training workforce: curriculum, skills, and entrepreneurs
Recommendations: Supply Chain for Urban Air Mobility Vehicles (*Drones and VTOLs*)

- Build a robust maintenance and reconditioning network and reliable authenticated parts supplier base
- Need global network to address MRO considerations related to operations – cycle time is critical
VTOLs and Drones will impact other supply chains

• Drones and VTOLs will impact supply chain deliveries as well
  • Hard to reach places
  • Tedious (e.g., bottom of Grand Canyon)
Summary

• Real need to build supply chain—drones are already here

• Global supplier base for OEMs and MROs is needed

• Rate of production and delivery needs to be significantly different than today’s aerospace manufacturing and assembly

• Parts access will need to be rapid for MROs

• Time to rebuild skills, talents, digital enterprise and attract new manufacturers to scale deliveries