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)
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
- **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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</thead>
</table>
| Considerations         | - Timeline  
                        - Cost  
                        - Quality  
                        - Margin  
                        - IP  
                        - Efficiency | - Forecast accuracy  
                        - Supply disruptions  
                        - Demand shifts  
                        - Inventory  
                        - Supply chain visibility  
                        - Lead times | - Supplier performance  
                        - Price volatility  
                        - Cost and prices  
                        - Lead times  
                        - Supplier due diligence | - Quality  
                        - Stock-outs  
                        - Waste  
                        - Capacity  
                        - Cost  
                        - Contract  
                        - Safety | - Ground time  
                        - On-time delivery  
                        - Network  
                        - Safety |
| 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 |
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
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
BACKUP
<table>
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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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