Aerospace & Defense Sector
Need for Innovation

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Agenda

• Summary messages
• Global commercial aerospace
• Aerospace manufacturing trends
• Disruptive innovation
• Future of aerospace
Summary Messages

• Commercial aerospace is a growth business
• But the industry is becoming commoditized, with pricing the main differentiator
• Process technology advances will supplant production labor content almost entirely; from aero-structures, electronics, systems to final assembly
• Winners will be those companies that design/produce parts that are more innovative; i.e., better before cheaper
Global Commercial Aerospace
Global Commercial Aerospace

- Travel demand at 4.8% CAGR is growing twice GDP rate
- 7.5 Trillion RPKs, 3.6 Billion enplanements annually
Global Commercial Aerospace

• Enplanements doubling to 7.2 Billion by 2035
• But only 6%-20% of the global population has ever flown

• Asia Pacific region will likely be the biggest demand driver for PAX growth in next 20 years
• China likely to be largest aviation market by 2024
• India will surpass UK as third largest by 2025

Source: IATA, Deloitte analysis
Global Commercial Aerospace

- Operating expenses per passenger km decreased 26% in last 10 years, due to increasing efficiency of airlines.

Operating expenses per revenue passenger kilometer

2006–2016E

Operating exp. per revenue passenger
kilometer (actual, in cents)

Source: Deloitte analysis, IATA
Note: Operating expenses per revenue passenger km is calculated as total airline operating expenses divided by revenue passenger km.
Global Commercial Aerospace

- 47% decrease in airfare costs since 1990, CPI adjusted
- Competition, efficiency, technology, scale economy

Real average passenger revenue per passenger kilometer; 1990–2016

Source: Deloitte analysis, IATA
Global Commercial Aerospace

- Industry consolidation, RPK growth, capacity discipline, low fuel prices, better cost structure, more revenue
- Airline operators now profitable & can afford new aircraft

Source: IATA, ICAO, Airlines.org, MIT, RITA, BTS, and Deloitte analysis
Global Commercial Aerospace

- PAX demand and airline profitability resulted in doubling of aircraft production in last decade
- Took 40 years to reach 500 a/c/y, then 20 years to reach 1,000 a/c/y, then 7 years to reach 1,500 a/c/y
Global Commercial Aerospace

- Aircraft backlog ~14,000 units and ~10 years of work
- Resulting in OEMs now increasing production rate
Global Commercial Aerospace

• In 20 years, total aircraft in service will grow from 23,480 to 46,950
• Most growth is in single aisle aircraft

Freighter – Light Green; Medium/large PAX widebody – Dark Green; Small passenger widebody – Light Blue; Single aisle – Navy Blue; Regional jets – Teal Blue

Source: Deloitte analysis, Airbus, Boeing
Global Commercial Aerospace

• 41,030 new aircraft in next 20 years worth $6.05 trillion
• 41% will replace older aircraft in service
Aerospace Manufacturing Trends
Aerospace Manufacturing Trends

- Process automation reducing labor content
- Globalization
- OEM outsourcing; some selective insourcing
- Offshoring, near-shoring
- Design authority driven down to suppliers
- Hardware to software centric
- Rate increases
- Selective vertical integration
- Industry consolidation
Aerospace Manufacturing Trends

- Advanced materials; stronger, lighter; alloys and composites
- Reduction in design variability
- Connected tools - IoT
- Manufacturing process innovations:
  - Additive manufacturing/3D printing
  - AI and machine learning; data analytics
  - Robotics and vision systems
  - Friction stir welding
  - Tool-less assembly
  - Non-destructive testing and QA
  - Advanced pressing, braking, forming & milling
Aerospace Manufacturing Trends

• Industry 4.0 is happening now, but widely misunderstood
• Nextgen sensors, big data, analytics, process automation and IoT
Disruptive Innovation
Disruptive Innovation

• New idea, industrialized into mass market, commoditized, supplanted by revolutionary newer idea providing leap ahead functionality, lower cost, appealing to mass market
• Repeat...repeat...repeat...
• Industrial convergence
Disruptive Innovation

*Industrial convergence driven by technology*

- Disruption spans all industries
- Caused by the inevitable march of commoditization
- New technology becomes old & at risk of exponential change
Disruptive Innovation

*Industrial convergence impacting aerospace*

- There are about 250,000 taxis in the US as of 2012
- With the emergence of ridesharing (Uber, Lyft, etc.), this has tripled to 750,000 as of 2018 behaving as taxis
- Creating a new market for on-demand urban mobility using disruptive innovation....Air taxis
Disruptive Innovation

Could this happen?

- If autonomous flight operations become reliable & safe, and if aircraft OEMs insource avionics, what happens to Rockwell Collins, Honeywell & Thales?
- If Directed Energy & Laser weapons become powerful & reliable, what happens to Raytheon, Remington, BAE Systems & other kinetic weapons companies?
- If battery power gains required scale, what happens to oil companies & Rolls Royce, Pratt & Whitney & GEA?
Disruptive Innovation

Could this happen to the Titanium industry?

• Are basic titanium products at risk of obsolescence and further commoditization; i.e. aluminum, sand, gravel, steel?
• What disruptive technologies could make titanium obsolete?
• What titanium innovations under development could be a disruption opportunity?
Future of Aerospace
Future of Aerospace

• A short but impressive history of innovation
• Creating the most importance advances in history
**Future of Aerospace**

Technological development in aerospace and aircraft design is advancing at an increasingly rapid pace

- 115 years since the Wright Bros first powered flight
- 41 years later, first jet powered flight
- 25 years later, first moon landing
- Wood/canvas to aluminum to carbon fiber composites in 75 years
- Future - Autonomous, electric, supersonic, smart
Future of Aerospace

• What are the future functional requirements for commercial aerospace?
  – Reduced/elimination of cost of fuel; typically 1/3 of the aircraft OpEx
  – Reduced labor costs of airline operations; flight crew, maintenance, air traffic control
  – Speed – get there faster
  – Acquisition costs; typically 30% of the life cycle costs
  – Superior and innovative passenger experience – beyond IFE&C
Future of Aerospace

**Propulsion & Integrated Electronics**
- Electric and hybrid engines
- On-board power generation
- Energy storage
- Integrated electric systems
- Energy re-use & conservation

**Autonomous Flight Control**
- Next Generation air traffic control
- Increased multi-spectral sensing & frequency
- AI and machine learning eliminating pilot error
- Significant reduction in cockpit human accommodations and labor cost

Source: Deloitte analysis
Future of Aerospace

**Speed**

- Supersonic - low boom acceptance
- Cut travel time in half
- Mostly long distance traffic routing
- Innovations in power and thrust
- Innovations in materials science

**Use Case Innovations**

- Urban mobility – air taxis – flying cars
- Space tourism
- Package delivery
- Robotic salvage operations, forestry, construction, security monitoring
Future of Aerospace

• Blending of markets; urban mobility, space travel, long range commercial travel

• Undreamed of technology innovations
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**Aerospace is a vital and essential industry**