Aviation’s Second Golden Age

Who will lead it?
From where?

September 2015
Agenda

Building / securing a leadership position in commercial aircraft:

1. Introduction – overall environment and 20 year major opportunity
2. Globalization – the fast-growing markets, fierce competition
3. Key Trends & Innovation – R&D and MNFG in the post-aluminum era
4. Where is commercial aircraft manufacturing poised for growth
   a. Leading Countries
   b. Which states in the US?
5. The push for A&D Talent – filling the pipeline
Harry K. Magazu, Director

Background

Harry is a Director in PwC’s Aerospace & Defense and Strategy practices, based out of Philadelphia. He brings 15+ years of strategy and operations consulting experience to his client work, primarily to Fortune 1000 companies, Tier 1 & 2 suppliers, and global PE funds.

Mr. Magazu has done considerable work defining and executing organic new business launch, as well as, technology commercialization and product launch strategies. Further, he has deep experience conducting strategic and operational planning improvement programs; and designing and implementing functional process improvements including: product development, engineering effectiveness, S&OP, strategic sourcing and OEE. He has both financial and operational turnaround restructuring experience and has served as the interim CFO for a new business launch, PE campaign. Harry has served as the full program manager for multiple large scale PDM and FLM business process and systems design and program implementations across the A&D, automotive, and industrial sectors.

As a member of our “M&A Deals Team”, his experience includes multiple commercial and operational diligences, as well as, leadership of several post close transformation planning, acquisition integration, value capture implementation, and sales side support programs across the A&D and Industrial sectors.

Prior to joining PwC, Harry was a member of the Booz&Co Aerospace & Defense consulting team, and was a NASA/DOD research engineer before earning his MBA and entering consulting. He has worked across the global A&D commercial and defense industries and held the required TSCI clearances.

Select project experience

- Led an R&D transformation at a major US Defense Electronics company - including: improving R&D portfolio funding, governance and management process and structures; increasing efficacy of CRAD strategies; and Developing an Advanced Development Organization to better pursue multi-mission programs
- Captured 12% operational savings from $725M global air and ground logistics operations baseline. Improved spans & layers, regions, hubs, & local markets.
- Defined and led a new supply chain and channel management breakdown strategy for a leading explosives and industrial equipment manufacturer. Created multiple JV partnerships, reduced capital invested by ~10%, increased GM by ~5%-10%, and reduced OpEx by ~$15M per year.
- Led multi-functional team to conduct a “Fit for Growth Assessment” of a major Tier 2 Defense Electronics company, identified, prioritized, and built capture plans for ~$60M in savings across engineering, manufacturing, supply chain support, and back office components
- Designed and implemented the strategic planning process and strategic projects assessment teams at a major air and ground logistics company.
- Led the development and implementation of multiple technology commercialization and product launch strategies across the US and Global defense industries
- Detailed all strategic and operational implementation plans for a $250M investment to create a new global, $2B air carrier business. Led negotiations with JV targets and strategic suppliers. Negotiated largest business jet OEM/service agreements in history. Established bundled pricing, service levels, operational footprint, detailed ISO9000 operational processes, defined all roles & reporting structures, and system requirements. Helped recruit & on-board senior team.
- Supported major areas of the crisis response and recovery efforts at a major global air carrier.
- Designed and led program to improve semi-custom order management and OEE at a major industrial toolmaker, improved EBITDA by 10% and OTD by 30%
- Led multiple A&D and Industrial acquisition strategies across the deal continuum – from strategy development, to target diligence, to post close planning & value capture - including: merger of two large A&D OEM’s, merger of two major global airlines, and multiple PE investments in the Tier 2 & 3 supply bases
- Defined & led implementations of multiple PLM strategic programs - including: program business case; scoping & phasing; business requirements & process design, software development, infrastructure architecture, and new user implementation go live. Brings multi industry PDM and PLM experience from work in A&D, electronics, industrial tool making, automotive, retail products and consumer segments. On average, led programs of > $15M budgets, captured >25% ROIs, implemented both PDM & PLM with full workflow and ERP integration across Planning-Costing-ENG-MNF-Service scope, as well as, led the design and implementation of load balancing full failover infrastructure.

Education

- Harry is a graduate of the University of Maryland, College Park, where he earned both his BS and MS degrees with honors in Aerospace Engineering
- Mr. Magazu has also completed an MBA from Columbia University, in New York City

September 2015
Introduction
A&D industry is setting records for a fifth year

The top 100 A&D companies set records in 2014, reporting $729 billion in revenue and $73 billion in operating profit. Operating profit was up 10%
Introduction
Looking forward aircraft demand is expected to boom

The aircraft sector is the country’s biggest net exporter, with a trade surplus of $75.1 billion in 2014.

Air traffic growth, driven by a growing middle class, is expanding, with an estimated 36,800 new planes worth $5.2 trillion needed over the next two decades to carry these new passengers.
**Introduction**

*There is good news for US manufacturers – but there is work to be done to capture the opportunity in the US*

This is good news for US manufacturers – but only for those positioned to pivot with these momentous **global trends** by creating a new generation of **talent** and propelling world-class manufacturing processes into lower cost solutions and/or insuring further structural **innovation beyond Aluminum and Titanium.**
The Aircraft market is 40% defense and 60% commercial, today’s focus is commercial AC

Aircraft Total Market Value
2014, Commercial Market is $286 billion

<table>
<thead>
<tr>
<th>Segment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Transport</td>
<td>- Single-aisle aircraft over 120 seats and all twin-aisle aircraft&lt;br&gt;- Designed to serve med- and long-range routes&lt;br&gt;- Market comprised of Boeing, Airbus and new entrants (e.g., Bombardier)</td>
</tr>
<tr>
<td>Regional</td>
<td>- Turbofan and turboprop aircraft with 50-120 seats for short-range travel&lt;br&gt;- Almost a duopoly with Bombardier &amp; Embraer&lt;br&gt;- However, New entrants (Mitsubishi, UAC, Sukhoi, AVIC) are challenging incumbents</td>
</tr>
<tr>
<td>Business Jet</td>
<td>- Aircraft segmented by range and cabin size&lt;br&gt;- Gulfstream, Bombardier, Cessna, and Dassault capture most of the market&lt;br&gt;- Demand drivers are different from air transport &amp; regional</td>
</tr>
</tbody>
</table>

Comm A&D market in 2014 = $286 billion
Original Equipment = $145 billion
Aftermarket (MRO) = $141 billion

Note: OE stands for Original Equipment
Source: Airline Monitor, Aerostrategy, Industry Interviews, VisionGain, IATA, Strategy & analysis
Commercial aircraft market will grow at ~6+% while defense / military rotorcraft will be flat

Aircraft Deliveries
2010-2035, Units

Value of Aircraft Deliveries
Original Equipment Only, 2010-2035, $ billion

CAGR
(2014-2035)
Military / Rotor:
~(-0.5%)

Commercial:
~6%

Note: Regional Jets and Air Transport aircraft are included in Commercial Fixed Wing segment
General Aviation and UAVs are not shown in this analysis
Source: Airline Monitor, Teal, Strategy& analysis
2014 A&D Industry Results – record sales & profits

- Record revenues and profits
- Surge in aviation market continues to offset weak defense performance
- Operating margin increased to 10%, reaching double digits for the first time
- Top quartile now has highest operating margin
- Defense sector reported another modest decline in revenue
- Uncertainty will loom as Budget Control Act of 2013 approaches expiration

5 year trend - Revenue

5 year trend - Operating Income
Average Margins range from 5% - 25% across the “The Commercial A&D Industry”

Commercial Aircraft Market Value Chain

| Suppliers | | | | | | |
|-----------|---|---|---|---|---|
| **Materials** | **Components & Assemblies** | **Major Subsystems** | **Airframer** | **Lessor\(^1\)** | **Operator** |
| - Aluminum | - Valves | - Engines | - Narrow body | - Operating Lease | - Passenger airlines |
| - Steel | - Actuators | - Landing gear | - Wide body | - Capital Lease | - Cargo operators |
| - Titanium | - Sensors | - Avionics | - Regional Jet | | |
| - Nickel alloy | - Wheels & brakes | - ECS | | | |
| - Composites | - Switches | - Fuel System | | | |
| | - Transducers | - Flight Controls | | | |

Products/Service

- Components: Alcoa, Cytec, Toray, Timet, Kaiser, Timet, Carpenter
- Assemblies: UTAS, Esterline, Ametek, Meggitt, Transdigm, Woodward, Crane, Precision Castparts
- Subsystems: Pratt & Whitney, UTAS, GE Aviation, Honeywell, Parker Aerospace, Eaton Aerospace, Liebherr, Moog
- Major Systems: Boeing, Airbus, Embraer, Bombardier
- Airframer: GECAS, ILFC
- Lessor\(^1\): United Airlines, Delta Airlines, Lufthansa
- Operator: Pratt & Whitney, Delta TechOps, United Services, Lufthansa Technik, ST Aerospace, Chromalloy, HEICO, Wencor
- MRO: Spare parts providers, Repair providers, Service suppliers, PMA parts suppliers, Surplus parts vendors

Example Companies:

- Materials: Alcoa, Cytec, Toray, Timet, Kaiser, Timet, Carpenter
- Components: UTAS, Esterline, Ametek, Meggitt, Transdigm, Woodward, Crane, Precision Castparts
- Assemblies: Pratt & Whitney, UTAS, GE Aviation, Honeywell, Parker Aerospace, Eaton Aerospace, Liebherr, Moog
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- Operator: United Airlines, Delta Airlines, Lufthansa
- MRO: Spare parts providers, Repair providers, Service suppliers, PMA parts suppliers, Surplus parts vendors

Avg. EBIT Margin %

- 5-20%
- 15-25%
- 10-15%
- 5-10%
- TBD
- 0-5%
- Varies

Companies often serve multiple tiers depending on the product category (e.g., UTAS provides landing gear as Tier I, Generators as Tier II, and Sensors as Tier III)

1) Depending on operator, lessors may or may not be a part of the value chain
The MRO segment has shown the largest EBITDA growth in the aerospace industry

USA: EBITDA Growth Index

Source: Grant Thornton Reports

September 2015
**Importance of foreign investors and PE companies is increasing in the A&D industry**

Transactions by Acquiring Company Type

- **2010**
  - PE/Consortium Investment: 23%
  - Others: 77%

- **2011**
  - PE/Consortium Investment: 32%
  - Others: 68%

- **2012**
  - PE/Consortium Investment: 27%
  - Others: 73%

Transactions by Country of Acquiring Company

- **2010**
  - USA: 17%
  - Others: 83%

- **2011**
  - USA: 29%
  - Others: 71%

- **2012**
  - USA: 43%
  - Others: 57%

Source: Grant Thornton Reports

September 2015
Globalization

Where are the fast-growing markets, fierce global competition
Commercial aviation backlog continues to grow to historic levels (now at 9 years of demand)

- Industry net orders were 2,888 in 2014
- New record (previous record in 2013: 2,858)
- 4\textsuperscript{th} consecutive year > 2,000 (5\textsuperscript{th} in history)
- Backlog reaches record of 12,175 aircraft, or about 9 years at current production levels
- Production record >6\% than prior (35\% higher than 2011)

<table>
<thead>
<tr>
<th>Backlog (US$ billions)</th>
<th>12/31/14</th>
<th>12/31/13</th>
<th>12/31/12</th>
<th>12/31/11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boeing</td>
<td>$440</td>
<td>$374</td>
<td>$319</td>
<td>$293</td>
</tr>
<tr>
<td>Airbus*</td>
<td>$919</td>
<td>$757</td>
<td>$638</td>
<td>$679</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Boeing</th>
<th>Airbus</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backlog, Dec 31, 2013</td>
<td>5,080</td>
<td>5,559</td>
<td>10,639</td>
</tr>
<tr>
<td>Orders, net</td>
<td>1,432</td>
<td>1,456</td>
<td>2,888</td>
</tr>
<tr>
<td>Deliveries</td>
<td>723</td>
<td>629</td>
<td>1,352</td>
</tr>
<tr>
<td>Backlog, Dec 31, 2014</td>
<td>5,789</td>
<td>6,386</td>
<td>12,175</td>
</tr>
</tbody>
</table>

*At list price
Growth in commercial A&D will be driven by a rise in personal income & GDP in developing countries

Passenger Air Trips vs. GDP per Capita (2012)

Even if there was no increase in population, because of rising wealth, Indian and Chinese air travel would be expected to more than double by 2030.

Note: 2030 Projection based on EIU GDP and population projection projections, and assumption that Pax will grow with GDP; Analysis based on power regression with an R2 of .70
Source: World Bank, EIU, Booz & Company Analysis

R² = .70

October 2015
Globalization
Fast-growing markets, fierce competition

- Asia Pacific leads global aircraft demand
- Highest growth in Africa, Middle East, and Latin America

- Demand for 36,800 new jet aircraft from 2015-2034 (avg. 1,840 per year, 36% higher than last year’s record production)
- By 2034, an estimated 32% of global airline passenger traffic is expected to exist in Asia Pacific (up from 28% in 2011)
- Beijing Capital International Airport – the world’s second busiest – saw 81 million passengers pass its gates in 2012 (up from 27 million a decade earlier)
- China alone plans to build 100 airports in the next two years, with most of these airports used for domestic travel
- China’s business jet inventory rose 40% to 326 in 2012; one estimate puts deliveries hitting 10,000 by 2021

### AC Units

<table>
<thead>
<tr>
<th>Region</th>
<th>2015</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia Pacific</td>
<td>13,460</td>
<td>2,950</td>
</tr>
<tr>
<td>North America/Europe</td>
<td>15,000</td>
<td>2,950</td>
</tr>
<tr>
<td>Middle East</td>
<td>2,950</td>
<td>2,950</td>
</tr>
<tr>
<td>Latin America</td>
<td>2,950</td>
<td>2,950</td>
</tr>
</tbody>
</table>

### Total Value

<table>
<thead>
<tr>
<th>Region</th>
<th>2015</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia Pacific</td>
<td>$2.02B</td>
<td>$0.64B</td>
</tr>
<tr>
<td>North America/Europe</td>
<td>$1.91B</td>
<td>$0.34B</td>
</tr>
<tr>
<td>Middle East</td>
<td>$0.64B</td>
<td>$0.34B</td>
</tr>
<tr>
<td>Latin America</td>
<td>$0.34B</td>
<td>$0.34B</td>
</tr>
</tbody>
</table>
Technology has led to fuel efficiency & flight range gains that greatly enable AC demand growth

Source: Air Transport Action Group
Material tech will continue to be a key enabler of low weight, higher strength, AC designs

### Key Aircraft Compositions
Fly Weight\(^1\) %

<table>
<thead>
<tr>
<th>Aircraft Model</th>
<th>Composition %</th>
<th>Major Composite Aerostructures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Al</td>
<td>Composite</td>
</tr>
<tr>
<td>787</td>
<td>20%</td>
<td>50%</td>
</tr>
<tr>
<td>A350</td>
<td>20%</td>
<td>53%</td>
</tr>
<tr>
<td>777X</td>
<td>25-30%</td>
<td>35-40%</td>
</tr>
<tr>
<td>777</td>
<td>50%</td>
<td>12%</td>
</tr>
<tr>
<td>A320NEO &amp; A320</td>
<td>55%</td>
<td>5-10%</td>
</tr>
<tr>
<td>737MAX &amp; 737NG</td>
<td>50%</td>
<td>5-10%</td>
</tr>
</tbody>
</table>

### Aircraft Raw Material Demand ’14-’24\(^1\)
Material Buy Weight\(^2\), m lbs.

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Composition %</th>
<th>CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Al</td>
<td>Composite</td>
</tr>
<tr>
<td>Total</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Composites</td>
<td>4.9%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1.0%</td>
<td></td>
</tr>
<tr>
<td>Super Alloys</td>
<td>1.2%</td>
<td></td>
</tr>
<tr>
<td>Titanium Alloys</td>
<td>3.6%</td>
<td></td>
</tr>
<tr>
<td>Steel Alloys</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>-0.5%</td>
<td></td>
</tr>
</tbody>
</table>

1) Includes all aircraft systems including aerostructures, components, and engines.
2) “Buy Weight” represents total material needed for production; “Fly Weight” represents finished aircraft.
3) Source: ICF, Strategy& analysis.

September 2015
The Boeing-Airbus duopoly is an aberration – typically it has been a “2+1” or “3+1” model.

**Number of Competitors in Single-Aisle Jet Airliners**
Products with 110+ Seat Derivatives; More than 5 Deliveries in Given Year

- **“2+Many”**
  - Boeing
  - Douglas
  - Tupolev, DeHavilland, Sud Aviation, Convair, Dassault, Vickers, BAC and Hawker Siddeley

- **“2+1”**
  - Boeing
  - Douglas
  - Tupolev

- **“3+1”**
  - Boeing
  - Douglas
  - Airbus
  - Tupolev

- **“Only 2”**
  - Boeing
  - Airbus

Year:
- 58
- 60
- 62
- 64
- 66
- 68
- 70
- 72
- 74
- 76
- 78
- 80
- 82
- 84
- 86
- 88
- 90
- 92
- 94
- 96
- 98
- 00
- 02
- 04
- 06
- 08
- 10
- 12
- 14
- 16
- 18
- 20

September 2015
Globalization presents a great opportunity
Fast-growing markets, fierce competition for technology and workforce

Who will design and sell 36,800 planes?
Who will own new material and technology breakthroughs “the post aluminum age”? 
Who will manufacturing 36,800 planes?
Where will they be made?
Does MFG have to be co-located with design (R&D/ENG)?

Boeing/Airbus duopoly is going to be / is being challenged:

- China (COMAC)
- Canada (Bombardier C-series)
- Brazil (Embraer’s upgraded E-Jet series)
- Russia (Irkut MS-21)
- Japan (Mitsubishi Regional Jet)
- HAL (Indian regional jet)
Globalization
PwC 2015 global aerospace manufacturing country attractiveness index

Methodology
PwC’s analysis compared countries in terms of their attractiveness as locales for commercial aircraft manufacturing. Our study created an “attractiveness ranking index” which primarily used a weighted average of three major elements:
1. Costs (taxes, manufacturing wages, productivity),
2. Industry size (number of existing suppliers)
3. Infrastructure/stability/talent (including quality of electrical and transportation infrastructure, regulatory/legal/corruption rankings and enrollments in, and quality of, engineering programs).

Changes from Prior Year
Major enhancements from last year include the addition of infrastructure and stability metrics to the workforce element. These additions help provide a more robust assessment of the manufacturing environment in which the aerospace companies are (or will be) operating. Refinements from last year’s rankings methodology include the addition of new tax variables and the use proportionality in our industry rankings. The latter adjustment better reflects the difference in magnitude of suppliers between countries (e.g. the US has 7x the number of suppliers as the next largest country).
Globalization

The US is well positioned to build upon it’s A&D leadership position

Top A&D 10 countries by rank

<table>
<thead>
<tr>
<th>Country</th>
<th>Cost rank</th>
<th>Industry rank</th>
<th>Infrastructure/stability/workforce rank</th>
<th>Overall rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>61</td>
<td>1</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>Singapore</td>
<td>7</td>
<td>140</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Hong Kong SAR, China</td>
<td>4</td>
<td>142</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Switzerland</td>
<td>10</td>
<td>141</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>21</td>
<td>122</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>Canada</td>
<td>11</td>
<td>134</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Qatar</td>
<td>1</td>
<td>142</td>
<td>19</td>
<td>7</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>2</td>
<td>142</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>14</td>
<td>142</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Ireland</td>
<td>12</td>
<td>142</td>
<td>22</td>
<td>10</td>
</tr>
</tbody>
</table>

About PwC’s analysis: Our study created an “attractiveness ranking index” which primarily used a weighted average of variables: costs (taxes, manufacturing wages, energy), workforce (including enrollments in, and quality of, engineering programs, as well as productivity) and size of existing industry.
Globalization

Operating cost is an emerging issue for the US A&D firms

Industry:

• The US ranks #1 in aerospace manufacturing in comparison to population

Cost:

• The US ranks 51st in cost, the worst among the top 10 overall countries and threatens this core industry
• The US ranks worse in cost than European countries such as France, UK, Germany, and Belgium
• Corporate Tax rate factors into total costs
• The US ranks high in all cost categories: wages, income/corp tax, tariffs, and energy
• By comparison, Canada had a lower income tax; European countries have similar wage and income taxes, but lower tariffs and energy costs

Talent:

• The US ranks high in its secondary education system, but low in STEM enrollment
• The US scored well in productivity and lower in productivity improvement
Globalization
*Key national priorities for US leadership of A&D in the next century*

- Import / Export Bank
- Corporate Tax Rate
- Penalties on on-shoring foreign profit
- Need to attract and develop a new generation of US talent
  - H1 visa policies limiting the pull into US of global talent
  - Lack of a national program to drive A&D interests (Apollo, Shuttle, Space Station,...)
  - Competition with Hi tech industry career paths
Globalization

The Overall Takeaways: To thrive globally, US companies need to invest in lower cost systems, develop-secure-&-nurture local talent and be vigilant when partnering with local firms, employ strict material and process IP protection measures and careful technology transfer strategies, & push for lower tax structures for their exports.

Key US National Areas of Focus:

- Import / Export Bank
- Corporate Tax Rate
- Penalties on on-shoring foreign profit

- Need to attract and develop talent
  - H1 visa policies limiting the pull into US of global talent
  - National program to drive A&D interests (IE Apollo, Shuttle)
  - Competition with Hi tech industry career paths
Where is commercial aircraft manufacturing poised for growth in the US?

### Methodology
PwC analyzed the relative “aerospace industry attractiveness” of the US in a state-by-state comparison. Our study produced an overall “attractiveness ranking index” using a weighted average of the following major elements: taxes, operating costs (industry and overall wage rates, business climate, energy costs), industry size (existing suppliers and supply/growth of workforce including available aerospace technicians, engineers, mechanics) and educational attainment.

### Changes from Prior Year
Enhancements from last year’s index include the creation of a separate category for integrated tax and the use of effective tax rates instead of statutory rates. Operating costs now reflect both industry wage rates and overall employee wages which provides a better gauge of wage dynamics in the state and a more appropriate weighting to labor (relative to other expenses) in the operating costs category. Finally, the industry ranking now includes employment growth rates (in addition to number of employees) and is based on aerospace companies as well as metal fabricators as opposed to broader manufacturing talent.
## PwC 2015 US A&D MNFG State Attractiveness

### Major Sources

<table>
<thead>
<tr>
<th>#</th>
<th>Component</th>
<th>Metric</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Opex</td>
<td>Industrial prices</td>
<td><a href="http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a">http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a</a></td>
</tr>
<tr>
<td>3</td>
<td>Opex</td>
<td>Mean hourly wage</td>
<td><a href="http://www.bls.gov/oes/current/oessrcst.htm">http://www.bls.gov/oes/current/oessrcst.htm</a></td>
</tr>
<tr>
<td>4</td>
<td>Opex</td>
<td>Mean hourly wage</td>
<td><a href="http://www.bls.gov/oes/current/oessrcst.htm">http://www.bls.gov/oes/current/oessrcst.htm</a></td>
</tr>
<tr>
<td>10</td>
<td>Industry</td>
<td>Companies</td>
<td>CapitalIQ</td>
</tr>
</tbody>
</table>
Where is commercial aircraft manufacturing poised for growth in the US?

Top 10 States - A&D Industry Attractiveness Ranking

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<th>States</th>
<th>Tax rank</th>
<th>Opex rank</th>
<th>Industry rank</th>
<th>Education rank</th>
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Overall A&D Industry Attractiveness Ranking by State

Source: TaxFoundation.org, EIA.gov, BLS.gov, CapitalIQ, and Census.gov

PwC September 2015
Top 5 State’s Operating Cost Detail

Operating Cost Rank by Sub Category
Overall top 5 by Category

Michigan Raw Scores
- Electricity = 7.73 cents/kwh
- Employment = 4 million workers
- Wage (aerospace) = $97.79 per hour
- Wage (all jobs) = $21.42 per hour

Source: TaxFoundation.org, EIA.gov, BLS.gov, CapitalIQ, and Census.gov
Top 5 State’s Tax Cost Detail

Integrated Tax Ranking by State

Source: TaxFoundation.org, EIA.gov, BLS.gov, CapitalIQ, and Census.gov


Top 5 State’s Industry Size / Stability Detail

Industry Size / Stability Rank by Sub Category
Overall top 5 by Category

Michigan Raw Scores
- Aerospace Employment = 2,720 workers
- Aerospace Growth = 30%
- Aerospace companies = 75

Aerospace Employment
- FL: 7
- MI: 6
- OH: 9
- UT: 10
- VA: 20

Aerospace Growth
- FL: 2
- MI: 11
- OH: 29
- UT: 35
- VA: 4

Aerospace Companies
- FL: 3
- MI: 6
- OH: 9
- UT: 2
- VA: 21

Overall
- FL: 5
- MI: 3
- OH: 1
- UT: 7
- VA: 19

Source: TaxFoundation.org, EIA.gov, BLS.gov, CapitalIQ, and Census.gov

PwC
Top 5 State’s Education & Tech Workforce Detail

Tech & AD Education Rank by Sub Category
Overall top 5 by Category

Michigan Raw Scores
- Bachelors = 1,089,029 attained
- Masters = 514,299 attained
- Doctorate = 79,507 attained
- % Bachelors = 26.9% attained
- % Graduate = 18.0% attained

Source: TaxFoundation.org, EIA.gov, BLS.gov, CapitalIQ, and Census.gov
## Top 20 states and scores by major criteria

<table>
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<th>Overall</th>
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September 2015
Top Industry Issues:

- Talent retention
- Innovation
- Globalization pressures/ opportunities
- Availability of capital
- Cost of labor
- Cost management
- Energy costs
- Tax policy
- Regulations
- Infrastructure
- Supply chain innovation
- IP protection
- Cyber security
Innovation

R&D and manufacturing in the post-aluminum era
Innovation
R&D and manufacturing in the post-aluminum era

- **Composites** make aircraft lighter and more efficient
- **Automated** production, assembly, and inspection ensures quality and cuts lead times
- **Virtual** designs leads to production and design efficiencies
- **Digitized** communications and avionics leads to smarter aircraft
- Innovating **infrastructure** will allow industry expansion
- Price-stable, renewable **bio-fuels** can be a game-changer
The takeaway: Aviation manufacturing companies can consider co-opting automation practices from other industries (e.g., automotive) and collaborate with emerging developers of technology (carbon composites, bio-fuels) and manufacturing processes to maintain a leading edge as innovators and to diversify their businesses.
Talent

Filling the pipeline
A&D Talent – Supply Gaps are Emerging
Filling the pipeline

Estimated percentages of US jobs growth in selected aviation occupational fields, 2010–2020

Aviation workforce needs are expanding – not just the number but the kind of skillsets required:

- aerospace engineers
- materials engineers
- computer engineers
- mechanical engineers
- electrical & electronic engineers
- skilled manufacturing
- avionics technicians
- cyber security

A&D Talent - Companies are struggling to create dynamic career paths for top R&D and Eng talent

Common A&D R&D Career Path

Executive (<1%)
- CTO

Mid Level & Mgmt. (~20%)
- Technology Fellow
- Principal Investigator
- Lead Investigator

Technical Staff (80% of staff)
- Analyst Level 1-3

Common A&D Engineering Career Path

Executive (<1%)
- VP of ENG

Mid Level & Mgmt. (~20%)
- Engineering Fellow
- Principal Engineer
- Lead Engineer

Technical Staff (80% of staff)
- Engineering Levels 1-3

Lateral movements

A&D Common Career Path Structure

- Three Major levels: Technical Staff, Mid-Level Manager, Executive
- There are 5 rungs on the career ladder
- Each rung of the ladder is linked to the expected progress of competencies by time in grade
- Career path progression commonly spans +20 yrs
- Typically, 80% of technical staff plateau at the second rung – “Lead Engineer”
- R&D and Eng lateral moves are possible at all mid and low level rungs
A&D Talent – The Risk of Skillset Collapse

Filling the pipeline

Overall US A&D Workforce


- Increasing lack of interest among students pursuing aviation as a career
- Impending “retirement cliff” is a huge concern: more than 20% of the A&D workforce will be eligible for retirement by 2020
- Lack of new defense programs and national objectives
- Often require US citizenship or security clearance so international students can not meet needs

Client Case Example

Source: “Aviation Week Workforce Study 2012,” Aviation Week, 2012
A&D Talent – Demographic Challenges
Filling the pipeline

Major Areas of US Engineering Talent by Discipline

A&D Technical Footprint Discussion

- Eng talent is concentrated in clusters of competitive and often high-cost geographies
- The cost effective manufacturing locations have shifted from north east industrial and industrial mid-west to the sunbelt southern and western states
- A&D firms traditional co-locate Eng and Mfg. A&D leaders are strategically evolving their Eng & Mfg location strategies

I. Co-locate Eng and Mfg near talent clusters to ensure access to technical talent at higher operations cost

II. Co-locate Eng and Mfg in cost efficient region, and accept the additional talent recruiting challenges

III. Separate Eng and Mfg for best Eng performance at lowest Mfg cost, industry leaders are moving towards this model

Engineering Disciplines Areas of 3x Greater Than National Average
- Mechanical Engineers
- Electrical Engineers
- Aerospace Engineers
- Software Engineers

Lower Cost Mfg Regions ES Location
A&D Talent Development Opportunities

Filling the pipeline

States, Regions, & Companies are beginning to “own” the talent problem by investing more time and capital to train and educate a sustainable workforce:

- Committing dollars to STEM education through national education programs
- Collaborating with EDU on A&D curricula and training programs
- Building on existing transferable skills
- Offering on-campus internships and expanded scholarships
- Collaborating with local colleges to provide tech training certificate programs
- Creating joint Industry+EDU+Dept State for targeted economic development and innovative development models
Talent

The takeaway: Companies are being more proactive in defining more expansive career paths, as well as, forging ties with government and academia to attract, educate, and train the next generation of manufacturers and to capture and pass on the knowledge of veteran specialists nearing retirement.