U.S. Department of Commerce
Bureau of Industry and Security
Office of Technology Evaluation

U.S. Air Force C-17 Aircraft
Supply Chain Impact Assessment

Final Results
November 2018

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation. UNCLASSIFIED
Who We Are:

• **Bureau of Industry and Security (BIS)**

  **Mission:** Advance U.S. national security, foreign policy, and economic objectives by ensuring an effective export control and treaty compliance system and promoting continued U.S. strategic technology leadership

  - Develops export control policies
  - Issues export licenses
  - Prosecutes violators to heighten national security
  - Develops and implements programs that ensure a technologically superior defense industrial base

• **Office of Technology Evaluation (OTE)**

  **Mission:** OTE is the focal point within BIS for assessing the capabilities of the U.S. industrial base to support the national defense and the effectiveness of export controls

OTE Industry Surveys & Assessments Background:

• Under Section 705 of the Defense Production Act of 1950 and Executive Order 13603, ability to survey and assess:
  ➢ Economic health and competitiveness
  ➢ Defense capabilities and readiness

• Data is exempt from Freedom of Information Act (FOIA) requests

• Enable industry and government agencies to:
  ➢ Share data and collaborate in order to ensure a healthy and competitive industrial base
  ➢ Monitor trends, benchmark industry performance, and raise awareness of diminishing manufacturing and technological capabilities

OTE/OEA C-17 Project Overview

• Partnership with the U.S. Department of Defense, Office of Economic Adjustment (OEA), and in coordination with the City of Long Beach, to conduct a comprehensive survey and assessment of the C-17 aircraft supply chain industrial base

• Three Phase Project:
  • Phase I: C-17 Excess Tooling and Equipment Transfer Completed - 2015
  • Phase II: Survey Development and Industry Deployment
  • Phase III: Survey Compliance and Final Results
What is the C-17 Globemaster III Aircraft?

C-17 Aircraft Program

• The first C-17 production model was delivered to Joint Base Charleston, S.C. on June 14, 1993

• The USAF capped its C-17 fleet at 223 aircraft; its final delivery was on 12 September 2013

• Notable C-17 Missions
  - Operation Allied Force
  - Operation Iraqi Freedom
  - Operation Enduring Freedom
  - 2010 Earthquake Humanitarian Relief
  - 2011 Pakistan Flood Relief

Achievements of the C-17 Program

• The C-17 Globemaster III is the most flexible cargo aircraft to enter the airlift force

• The C-17 flew half of the strategic airlift missions in the Kosovo and Operation Allied Force

• The C-17 was awarded U.S. aviation's most prestigious award, the Collier Trophy, in 1994

C-17 Aircraft Production by Year

Phase II: Survey Development and Deployment

- **Survey Development and Outreach**
  - Develop survey data collection topics such as production, employment, financials, R&D, and competitive outlook
  - Conduct initial site visits to better understand the impact of the loss of C-17 aircraft sales on the industrial supply chain
  - Design, develop, and circulate the draft survey template for feedback from select organizations

- **Survey Approval**
  - Formally field test final version of C-17 aircraft supply chain survey
  - Obtain Office of Management and Budget (OMB) C-17 aircraft survey approval

- **Survey Deployment**
  - Format and code approved survey template
  - Distribute survey to all identified C-17 aircraft suppliers
  - Conduct respondent compliance to ensure quality and timely data analysis

Methodology - C-17 Aircraft Assessment

- Organization size was established based on sales from C-17 related products manufactured in the U.S.
  - Small: Under $10M in annual sales
  - Medium: $10M-$50M in annual sales
  - Large: Over $50M in annual sales

- BIS received responses from over 420 organizations, representing 544 facilities. Organizations were categorized by business type:
  - Distributor
  - Engineering Firm
  - Holding Company
  - Laboratory
  - Manufacturer
  - Non-Profit
  - Research & Development Firm
  - Service Provider
  - Testing Facility
Methodology - C-17 Aircraft Assessment

• Scope of survey and assessment was limited to organizations with U.S. operations that supported the C-17 program

  • OTE used a list of suppliers provided by the prime contractor and combined it with an internal list, which was accumulated through previous Defense Industrial Base studies and other suppliers identified by C-17 supplier organizations

• Survey exemption requests were handled individually and The Boeing Company was consulted on some cases

  • If Boeing and the USAF was not a customer since 2012 and the respondent’s products/services were generic, an exemption would be provided

  • Respondents that had Boeing and/or the USAF as a customer since 2012 but were unaware of specific C-17 support were NOT provided an exemption generally
Type of Supply Chain Support
Self-Identified Support of C-17 Program by Type and Time Period (1991-2018)

- Both Former and Current: 149
- Former: 142
- Current: 85

Primary Customer: USAF or Boeing

Primary Customers for Known Support of C-17 Program

- Boeing Only: 291 respondents
- Both Boeing and USAF: 46 respondents
- USAF Only: 6 respondents
- Other: 39 respondents

10% of respondents did not list Boeing or USAF as a primary customer.

Respondent Profile
Type of Support to USAF or Boeing

- **Direct**
  - Boeing Only: 95
  - Both Boeing and USAF: 17
  - Other: 4

- **Indirect**
  - Boeing Only: 91
  - Both Boeing and USAF: 7
  - Other: 17
  - USAF Only: 2

- **Both Direct and Indirect**
  - Boeing Only: 63
  - Both Boeing and USAF: 47
  - Other: 1

Respondent Profile
Primary Customers of Suppliers to Boeing and USAF

- Boeing: 251 respondents (72% of all primary customers)
- Both: 71 respondents
- Other: 19 respondents
- USAF: 6 respondents

72% of all primary customers surveyed were suppliers to Boeing

Support of C-17 Program
Suppliers of USAF or Boeing with C-17 Support

- Former: 189, 45%
- Current: 71, 17%
- Has Never Supplied to USAF or Boeing: 78, 19%
- Both Current and Former: 82, 19%

Respondent Profile
Involvement with the Maintenance, Repair, and Overhaul of C-17 Program by Time Period and Primary Customer

Small Business Qualifications
Does Your Business Qualify as any of the Following Types?

- Small Business: 194, 48%
- 8 (a) Firm: 4
- HUBZone: 17
- Minority-owned: 26
- Woman-owned: 48
- Veteran-owned/service-disabled veterans: 15

Several respondents qualified for more than one of the drop downs.

194 out of 420 respondents identified as a small business.

Q1a, C

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation. UNCLASSIFIED
Out of 518 facilities, 191 or 45% of C-17 Facilities are located in California

Most respondents had at least 1 facility that supported the C-17 Program

Business Functions With C-17 Support
Number of C-17 Respondents By Type of Business Function

- Manufacturer: 238, Both: 39, Other Aircraft Only: 15
- Engineering: 69, Both: 16
- Distributor: 57, Both: 7, Other Aircraft Only: 3
- Service Provider: 52, Both: 9, Other Aircraft Only: 4
- Testing Facility: 27, Both: 4
- Research & Development: 18, Both: 9
- Laboratory: 12
- Holding Company/Headquarters: 5

Types of Company Restructuring per Year
Mergers, Acquisitions, and Divestitures from 2012-2017

<table>
<thead>
<tr>
<th>Year</th>
<th>Mergers</th>
<th>Acquisitions</th>
<th>Divestitures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-2012</td>
<td>1</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>2013</td>
<td>1</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>2014</td>
<td>1</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>2015</td>
<td>3</td>
<td>33</td>
<td>9</td>
</tr>
<tr>
<td>2016</td>
<td>1</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>2017</td>
<td>2</td>
<td>16</td>
<td>8</td>
</tr>
</tbody>
</table>

2015 accounted for 30% of all recorded restructuring

Q2, A & B

Acquisitions, Divestitures, and Mergers

Primary Objectives

Q2, A 420 Respondents

Joint Ventures Per Year
Joint Venture Activities from 1999-2017

- 27% of joint ventures were with Chinese companies. The majority of these respondents’ joint ventures were to expand customer base and seek new business opportunities.
- 80% of those with joint ventures with Chinese companies were classified as distributors.

BIS/OTE

C-17 Aircraft Supply Chain Impact Assessment

Top Products and Services Provided

<table>
<thead>
<tr>
<th>Product and Service Category</th>
<th>Primary Business Line</th>
<th>Additional Business Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>U: Raw Materials and Purchased Parts</td>
<td>141</td>
<td>58</td>
</tr>
<tr>
<td>A: Airframe - Forward, Center, and Aft Fuselages</td>
<td>64</td>
<td>59</td>
</tr>
<tr>
<td>V: Material Processing/Finishing</td>
<td>46</td>
<td>25</td>
</tr>
<tr>
<td>W: Testing, Evaluation and Professional Services</td>
<td>23</td>
<td>33</td>
</tr>
<tr>
<td>G: Hydraulic Systems</td>
<td>16</td>
<td>27</td>
</tr>
<tr>
<td>F: Fuel Systems</td>
<td>13</td>
<td>34</td>
</tr>
<tr>
<td>X: Aircraft Servicing, Repair and Overhaul</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>T: Cargo Compartment and Crew Accomodations</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>B: Airframe - Wings</td>
<td>8</td>
<td>99</td>
</tr>
<tr>
<td>E: Engine Build-Up Assembly and Nacelle</td>
<td>8</td>
<td>41</td>
</tr>
<tr>
<td>S: Environmental and Oxygen System</td>
<td>7</td>
<td>30</td>
</tr>
<tr>
<td>K: Landing Gear, Braking System and Loadmaster System</td>
<td>6</td>
<td>37</td>
</tr>
<tr>
<td>D: Vertical Stabilizer</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>C: Horizontal Stabilizer</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>I: Auxiliary Power Unit Systems</td>
<td>31</td>
<td></td>
</tr>
</tbody>
</table>

Respondents had 24 choices (A-X) to list their product and services

Q3, A 420 Respondents

Primary Business Lines
Top 5 Out of 24 Business Lines

- U: Raw Materials/Purchased Parts
  - Product: 405
  - Service: 22
  - Both: 71

- A: Airframe: Fuselages
  - Product: 401
  - Service: 24
  - Both: 36

- B: Airframe: Wings
  - Product: 249
  - Service: 26
  - Both: 33

- V: Material Processing/Finishing
  - Product: 80
  - Service: 73
  - Both: 24

- X: Aircraft Servicing, Repair and Overhaul
  - Product: 31
  - Service: 48
  - Both: 38

Q3, C-E

Program Participation
Number of Federal, State, and Local Programs Supported Since 2012

30% of respondents
support more than
10 Federal, State,
and Local programs

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation. UNCLASSIFIED
Nearly 60% of respondents noted that Federal, State, and Local programs account for 20% or less of total revenue.

Program Participation
Top Federal, State, Local Customers Since 2012 by Support Type

<table>
<thead>
<tr>
<th>Customer Type</th>
<th>Indirect Support</th>
<th>Direct Support</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>All other DoD Operations</td>
<td>155</td>
<td>136</td>
<td>50</td>
</tr>
<tr>
<td>U.S. Air Force</td>
<td>122</td>
<td>98</td>
<td>25</td>
</tr>
<tr>
<td>Non-Defense USG</td>
<td>41</td>
<td>30</td>
<td>11</td>
</tr>
<tr>
<td>State/Local Government</td>
<td>2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Intelligence Community (non-DoD)</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

84% of respondents supported DoD related programs
16% of respondents supported Non-DoD related programs

Q4, B3

USG Programs Support
Top 10 Products/Services Supported through USG Work

- U24 - Other Purchased Part: 170
- U11 - Fasteners: 83
- F4 - Other Fuel System: 82
- G4 - Other Hydraulic System: 78
- U4 - Castings and Forgings: 76
- V6 - Other Material Processing/Finishing: 69
- U9 - Connectors: 57
- M4 - Other Guidance, Navigation and Control: 54
- U1 - Aluminum Sheet/Plate/Rod: 51
- U19 - Switches: 49

769 Total Products and Services

“Other” responses include Searchlights, Control Actuation, and Hardware Consumables among other miscellaneous products

Q4, C

USG Program Support
Top 10 DoD Programs Supported

- **Boeing Helicopter (Chinook, Apache, etc.):** 156
- **Lockheed Martin F-35 Lightning II:** 155
- **Boeing (McDonnell Douglas) F/A-18 Hornet:** 140
- **Bell Boeing V-22 Osprey:** 139
- **Lockheed C-130 Hercules:** 136
- **Boeing F-15 Eagle:** 132
- **Boeing KC-46:** 101
- **Lockheed Martin F-22 Raptor:** 97
- **Boeing P-8 Poseidon:** 95
- **Sikorsky Helicopter (MH-53E Sea Dragon, Black Hawk, etc.):** 91

# USG Program Support

Top 3 Primary Products/Services Supported by DoD Program

<table>
<thead>
<tr>
<th>USG Program</th>
<th># of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boeing Helicopter (Chinook, Apache, etc.)</td>
<td></td>
</tr>
<tr>
<td>Lockheed Martin F-35 Lightning II</td>
<td></td>
</tr>
<tr>
<td>Boeing (McDonnell Douglas) F/A-18 Hornet</td>
<td></td>
</tr>
<tr>
<td>Bell Boeing V-22 Osprey</td>
<td></td>
</tr>
<tr>
<td>Lockheed C-130 Hercules</td>
<td></td>
</tr>
<tr>
<td>Boeing F-15 Eagle</td>
<td></td>
</tr>
<tr>
<td>Boeing KC-46</td>
<td></td>
</tr>
<tr>
<td>Lockheed Martin F-22 Raptor</td>
<td></td>
</tr>
<tr>
<td>Boeing P-8 Poseidon</td>
<td></td>
</tr>
<tr>
<td>Sikorsky Helicopter (MH-53E Sea Dragon, Black Hawk, etc.)</td>
<td></td>
</tr>
</tbody>
</table>

USG Program Support
Top DoD Programs Supported and C-17 Termination Impact

Boeing Helicopter (Chinook, Apache, etc.)
- No Change: 131
- Unknown: 15
- Negative Impact: 7
- Positive Impact: 2

Lockheed Martin F-35 Lightning II
- No Change: 132
- Unknown: 12
- Negative Impact: 11
- Positive Impact: 1

Boeing (McDonnell Douglas) F/A-18 Hornet
- No Change: 121
- Unknown: 11
- Negative Impact: 7
- Positive Impact: 1

Bell Boeing V-22 Osprey
- No Change: 115
- Unknown: 11
- Negative Impact: 12
- Positive Impact: 1

Lockheed C-130 Hercules
- No Change: 115
- Unknown: 10
- Negative Impact: 7
- Positive Impact: 2

Boeing F-15 Eagle
- No Change: 111
- Unknown: 12
- Negative Impact: 8
- Positive Impact: 2

Boeing KC-46
- No Change: 86
- Unknown: 9
- Negative Impact: 6
- Positive Impact: 0

Lockheed Martin F-22 Raptor
- No Change: 82
- Unknown: 7
- Negative Impact: 8
- Positive Impact: 0

Boeing P-8 Poseidon
- No Change: 85
- Unknown: 5
- Negative Impact: 5
- Positive Impact: 0

Sikorsky Helicopter (MH-53E Sea Dragon, Black Hawk, etc.)
- No Change: 82
- Unknown: 45
- Negative Impact: 0
- Positive Impact: 0

Sales and Customers
Average Sales Per Year 2012-2016

Average total sales increased by 13.5% from 2012 to 2016

Sales and Customers
Aggregate Sales Per Year: 2012-2016

Total sales increased by 20% from 2012 to 2016

Sales and Customers
Aggregate U.S. and Non-U.S. Sales: 2012-2016

Between 2012-2016, Non-U.S. sales grew by 31%
U.S. sales grew by 19%

Average Percentage of Attributable Sales
Broken Down By Category: 2012-2016

Revenue streams can be accounted for in more than one production category

Sales and Customers
Estimated Direct Customers Per Respondent: 2012-2016

- 420 respondents supported an estimated 433,000 direct customers
- The average respondent supported 182 direct customers
- Only 77 respondents reported over 1,000 direct customers
  - 57% (44) of these respondents were categorized as distributors

Type of Customer Supported
Number of Respondents By Type of Customer 2012-2016

Commercial, 2585, 87%
Government Defense, 325, 11%
Government Non-Defense, 13, 1%
Other Customers, 39, 1%
Other, 52

Type of Aircraft Supported
Number of Customers By Aircraft Supported: 2012-2016

- Other aircraft only, 2328, 73%
- C-17 and other aircraft, 320, 10%
- Unknown, 503, 16%
- C-17 only, 42, 1%

1.3% of identified customers were exclusively involved with C-17 production

Sales and Customers
Top 15 Non-U.S. Customers by Country 2012-2016

Out of 445 Non-U.S. customers, 35% or 156 are attributable to European Union members.

C-17 Termination
Impacts Due To The Termination of The C-17 Program 2012-2016

15% of respondents lost customers due to the termination of the C-17 program.

Q5, C

Pre-Termination Business Model
Respondents’ Most Recent Year of C-17-Related Activities

The spike in 2017 can be attributed to spare parts, repairs, maintenance, and repurposing for foreign orders of the C-17 aircraft.

Domestic production of the C-17 aircraft ended in 2013.

C-17 Production by Company Size

What type of businesses were involved in the C-17 Aircraft Supply Chain?

Approximately 30% of companies involved in C-17 aircraft production were small businesses.
C-17 Termination Notification

Was your organization notified in advance of the C-17 aircraft program termination?

- Yes, 185, 44%
- No, 102, 24%
- Unknown, 133, 32%

25% of respondents were not notified of the termination of the C-17 program.

C-17 Termination Notification
Source of Notification of the Termination of C-17 Production

- Boeing, 155, 84%
- Other, 29, 16%
- USAF, 1, 0.54%

“Other” - respondents commonly indicated they were notified by either lower-tier customers or the media

C-17 Termination Business Transition

Did the termination of the C-17 program change your organization's involvement in the defense industry?

- Yes, 56, 13%
- No, 343, 82%
- Not Applicable, 21, 5%

How was your participation in the defense industry affected?

<table>
<thead>
<tr>
<th>Participation Status</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Involvement in Defense</td>
<td>49</td>
</tr>
<tr>
<td>Increased Involvement in Defense</td>
<td>3</td>
</tr>
<tr>
<td>Left Defense Industry</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>56</strong></td>
</tr>
</tbody>
</table>

C-17 Termination Business Transition
Did the termination of the C-17 program change your organization's involvement in the aerospace industry?

- No, 364, 87%
- Yes, 33, 8%
- Not Applicable, 23, 5%

How was your participation in the aerospace industry affected?

<table>
<thead>
<tr>
<th>Participation</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Involvement in Aerospace</td>
<td>24</td>
</tr>
<tr>
<td>Increased Involvement in Aerospace</td>
<td>7</td>
</tr>
<tr>
<td>Left Aerospace Industry</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
</tr>
</tbody>
</table>
C-17 Termination Business Transition
Did your organization substitute your C-17 sales with a new or different program?

Yes, 193, 46%
No, 109, 26%
Haven't Tried/Don't Know, 118, 28%

Platform for C-17 sales substitutions

<table>
<thead>
<tr>
<th>Platform</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>USG</td>
<td>21</td>
</tr>
<tr>
<td>Commercial</td>
<td>60</td>
</tr>
<tr>
<td>Both USG and Commercial</td>
<td>112</td>
</tr>
<tr>
<td>Total</td>
<td>193</td>
</tr>
</tbody>
</table>

Q6, B3
C-17 Termination Business Transition
Commercial Platforms Used as Substitute for C-17 Program

- Boeing Commercial Jets/Aircraft: 149 respondents
- Airbus Commercial Jets/Aircraft: 78 respondents
- Other Small Aircraft: 66 respondents
- Other Commuter Aircraft (Bombardier DHC-8, Embraer 145, etc.): 58 respondents
- Other Transport Aircraft (Illyushin Il-96, Bombardier Cseries, etc.): 30 respondents

"Even still, these platforms haven't been much of a substitute. We don't do near the volume we did with C-17."

-Q6, B4

C-17 Termination Business Transition
Top 15 DoD Platforms Used as Substitute for C-17 Program

Lockheed Martin F-35 Lightning II: 76
Bell Boeing V-22 Osprey: 35
Boeing F/A-18 Hornet: 33
All Other DoD: 28
Lockheed C-130 Hercules: 27
Boeing Helicopter (Chinook, Apache, etc.): 27
Boeing F-15 Eagle: 27
Boeing KC-46: 20
Boeing P-8 Poseidon: 16
Bell Helicopter (AH-1 SuperCobra, UH-1, etc.): 14
Sikorsky Helicopter (MH-53E Sea Dragon, Black Hawk, etc.): 13
Other - Drone: 13
Other - Cargo/Transport: 9
Northrop Grumman E-2 Hawkeye: 9
Lockheed Martin F-22 Raptor: 7

*The top 15 out of 37 categories accounted for 28% of total substitutes*

Did your organization adjust its business plan in response to the C-17 Aircraft program's termination?

- Yes, 57, 14%
- No, 319, 76%
- Not Applicable, 25, 6%
- Unknown, 19, 4%

14% of organizations adjusted their business plans due to the C-17 programs termination.
C-17 Termination Lessons Learned
Leading Actions Used for Business Plan Alterations After C-17 Termination

- **Other**: 31
- **Reorganization**: 18
- **Retraining of Employees**: 18
- **Repurpose of Equipment**: 14
- **Liquidation of High Value Assets**: 7
- **Increased Investment**: 7

“Other” frequently included laying off employees and adding more facilities in foreign countries.
C-17 Termination Lessons Learned
Self-Scoring of Organizations’ Response to C-17 Termination

Many companies were unaware of project termination while working on the C-17 program

- Managed with significant difficulties: 5% (20 respondents)
- Managed with only minor difficulties: 16% (60 respondents)
- Handled Moderately Well: 18% (70 respondents)
- Handled Well: 61% (236 respondents)

C-17 Termination Lessons Learned
Leading Advice for Vendors Experiencing the Loss of a USG Program

Other responses include: providing transition assistance, and providing earlier notice of termination.

- "Less concentration of customers and products offers less risk."
  - Small Business
- "Try to implement a balance of commercial work with multiple defense programs."
  - Large Business
- "Find other programs, sell, sell, sell."
  - Small Business

C-17 Termination Lessons Learned
Supplier Advice for Government and Defense Prime Contractors when Handling the Closure of a Major Program

Full Time Equivalent Employment

Average Number of FTE Employees Reporting at the Corporate and Division Level from 2012-2017

- Business Unit/Division FTEs
- Corporate/Whole Organization FTEs

64% of respondents reported FTE Employment at the Corporate/Whole Organization level

Full Time Equivalent Employment
Average FTE Employment by Company Size

Full Time Equivalent Employment
Aggregate FTE Employment by Company Size

FTE Employee Work Designations

Average Percentage of Defense, Aircraft, and C-17 Related Employees from 2012-2017

Employees can be categorized by more than one field


Q7a, A 420 Respondents
Full Time Equivalent Employment
Primary Business Line Full Time Employment Averages 2012-2017

Q7a, B

Workforce Operations
Primary Business Operation Lines of Employment

<table>
<thead>
<tr>
<th>Business Operation</th>
<th>% of Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distributor</td>
<td></td>
</tr>
<tr>
<td>Services</td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
</tr>
</tbody>
</table>

% of Employment
- Machinists
- Admin
- Marketing
- Engineers
- Testing/Support
- Design
- Facility/Maintenance
- IT

Q7a, B


420 Respondents
Difficulties Hiring and Retaining Workforce

Workforce Difficulties Stratified by Occupation

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Hiring</th>
<th>Retaining</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Workers/Machinists</td>
<td>21</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>Engineers, Scientists, R&amp;D Staff</td>
<td>18</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Testing, Quality, Support</td>
<td>10</td>
<td>48</td>
<td>54</td>
</tr>
<tr>
<td>Marketing and Sales</td>
<td>17</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>Admin, Management, Legal</td>
<td>18</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Facility and Maintenance Staff</td>
<td>25</td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>Designers</td>
<td>60</td>
<td>11</td>
<td>66</td>
</tr>
<tr>
<td>IT Professionals</td>
<td>35</td>
<td>15</td>
<td>52</td>
</tr>
</tbody>
</table>

Q7a, B

Impact of C-17 Termination on Workforce
Respondent Self-Identified Impact Severity on Workforce

Respondents indicated layoffs, reduction in benefits, reduction in overtime, and forced time off as the leading workforce impact they experienced.

Some large companies indicated that the C-17 termination allowed them to reallocate resources to new business opportunities, and to develop new technological advancements to replace losses in employment.

Workforce Preservation Plan

Do you have a workforce preservation plan for the post C-17 environment?

- Not Sure, 71, 17%
- Yes, 133, 32%
- No, 216, 51%

“Headcount is adjusted commensurate with sales volume to maintain profitability required by our investors.”
-Large Company

“We have additional contracts to sustain the workforce.”
-Large Company

“[We implemented] redeployment to project work for other customers, including non-aerospace customers.”
-Large Company

Q7b, A2


420 Respondents
### Implemented Workforce Modifications
Changes Made In Response to C-17 Termination

<table>
<thead>
<tr>
<th>Workforce Modifications</th>
<th># of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repurpose</td>
<td>14</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
</tr>
<tr>
<td>Retraining</td>
<td>9</td>
</tr>
<tr>
<td>Reduction in USG Trained personnel</td>
<td>4</td>
</tr>
<tr>
<td>Automation</td>
<td>3</td>
</tr>
<tr>
<td>Outsourcing</td>
<td>2</td>
</tr>
</tbody>
</table>

“Other” included layoffs of personnel

92 of 420 respondents indicated they made changes to their workforce

Q7b, A3

Loss of Critical Skills/Capabilities
Broken Down by Product or Service Line

<table>
<thead>
<tr>
<th>Product or Service</th>
<th>Losses Indicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airframe: Forward, Center and Aft Fuselage</td>
<td>3</td>
</tr>
<tr>
<td>Testing, Evaluation and Professional Services</td>
<td>1</td>
</tr>
<tr>
<td>Engineering Expertise</td>
<td>1</td>
</tr>
<tr>
<td>Flight Control Systems</td>
<td>1</td>
</tr>
<tr>
<td>Fuel Systems</td>
<td>1</td>
</tr>
<tr>
<td>Machining</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>38</td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
</tr>
</tbody>
</table>

Developmental Work With Outside Institutions
Respondents’ Indication of Work with Outside Institutions on Development/Training

Yes, 178, 43%
No, 232, 57%

"[We] work with local colleges on employee skills training.”
- Large Business

"[We conduct] thorough outreach of Colleges, Trade Schools, High Schools and Veterans/Disabled/Minority groups.”
- Large Business

"We visit classrooms, host interns, host MFGDAY, contribute to school programs and equipment.”
- Medium Business

Q7b, B1
420 Respondents

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation. UNCLASSIFIED
Developmental Work With Outside Institutions
Participation Broken Down by Business Size

- Large, 88
- Medium, 53
- Small, 37

Total Participation With Outside Institutions:
- 56% of Large Businesses
- 40% of Medium Businesses
- 28% of Small Businesses

42% of all businesses participated

Workforce Development Programs
Participation in Workforce Development Programs

<table>
<thead>
<tr>
<th>Program</th>
<th>Current Participation</th>
<th>Past Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>On Job Training</td>
<td>225</td>
<td>2</td>
</tr>
<tr>
<td>Tuition Reimbursement</td>
<td>182</td>
<td>10</td>
</tr>
<tr>
<td>Internship</td>
<td>149</td>
<td>34</td>
</tr>
<tr>
<td>Mentorship</td>
<td>128</td>
<td>7</td>
</tr>
<tr>
<td>Certification</td>
<td>127</td>
<td>8</td>
</tr>
<tr>
<td>Executive Training</td>
<td>107</td>
<td>11</td>
</tr>
<tr>
<td>Detail/Rotation</td>
<td>71</td>
<td>4</td>
</tr>
<tr>
<td>Apprenticeship</td>
<td>51</td>
<td>13</td>
</tr>
</tbody>
</table>

Q7b, B2

Workforce Development Programs

Developmental Programs Deemed Most and Least Useful Among Respondents in Post C-17 Transition

Q7b, B2

Critical Vendors & Suppliers
Total Supplier Support

• 1,307 unique suppliers supported 420 respondents

• The top 15 most cited suppliers only accounted for 7% of all supplier support

• 97% (1,267) of all identified unique suppliers are considered domestic

Critical Vendors & Suppliers
Suppliers by Country

- Canada: 9 suppliers
- United Kingdom: 8 suppliers
- France: 7 suppliers
- Germany: 6 suppliers
- Japan: 5 suppliers
- Israel: 5 suppliers
- Switzerland: 3 suppliers
- Mexico: 3 suppliers
- India: 3 suppliers
- Taiwan: 2 suppliers
- Sweden: 2 suppliers
- Singapore: 2 suppliers
- China: 2 suppliers
- Spain: 1 supplier
- South Korea: 1 supplier
- Malaysia: 1 supplier
- Ireland: 1 supplier
- Cameroon: 1 supplier

420 respondents were supported by a total of 62 Non-US suppliers

Q8, A

An estimated 1,307 unique suppliers supported 420 respondents.

California accounts for 35% of all identified vendors and suppliers.

Respondents could list multiple suppliers.

Q8, A

Critical Vendors & Suppliers
Top 10 Supplier Input Categories

<table>
<thead>
<tr>
<th>Input Category</th>
<th># of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Materials and Purchased Parts</td>
<td>1,113</td>
</tr>
<tr>
<td>Material Processing/Finishing</td>
<td>259</td>
</tr>
<tr>
<td>Testing, Evaluation and Professional Services</td>
<td>56</td>
</tr>
<tr>
<td>Airframe: Forward, Center and Aft Fuselage</td>
<td>28</td>
</tr>
<tr>
<td>Aircraft Servicing, Repair and Overhaul</td>
<td>28</td>
</tr>
<tr>
<td>Electrical Power System</td>
<td>23</td>
</tr>
<tr>
<td>Fuel Systems</td>
<td>22</td>
</tr>
<tr>
<td>Flight Control Systems</td>
<td>18</td>
</tr>
<tr>
<td>Landing Gear, Braking System and Loadmaster System</td>
<td>17</td>
</tr>
<tr>
<td>Communication and Recording Systems</td>
<td>16</td>
</tr>
</tbody>
</table>

Over 70% of identified suppliers provide raw materials and purchased parts

Q8, A 420 Respondents

Critical Vendors & Suppliers
Top 5 Supplier Input Product/Service Areas

- U24 - Other Purchased Part: 360
- U23 - Other Raw Material: 181
- U1 - Aluminum Sheet/Plate/Rod: 118
- V6 - Other Material Processing/Finishing: 103
- V1 - Coating and Painting: 87

Other Purchased Parts include Hydraulic Systems, and Switches
Other Raw Materials include Castings & Forgings, and Composites

Supplier Association With C-17 Program

Number of Respondent Suppliers Associated With C-17 Program

- C-17 Specific, 127, 8%
- Unknown, 637, 38%
- C-17 and other aircraft, 897, 54%

8% of 1,661 identified suppliers were exclusively involved in C-17 specific operations

Supplier Impacts
Impact of C-17 Termination On Domestic Supplier Shut Downs

Only one respondent indicated that one or more of their suppliers ceased operations following the termination of the C-17 program. Both suppliers were located in California. Both sold raw materials and purchased parts.

“Less income. Had to lay off long time employees.”
-Small Business

Operating Profit Margin

Average Operating Profit Margin Across Small, Medium, and Large Businesses

2012-2016

The average operating profit margin was 12.7% across all business sizes in 2015
Financial Risk Levels
Number of Companies and Financial Risk Level

Financial Risk calculation based primarily on profit margins, debt levels, liquidity

Reasons for lack of measurement:
Source data mismatches (e.g. reporting income statement data at the facility level and balance sheet data at the corporate level)

Unavailable or missing data (e.g. no assets or sales listed, newly formed business)

Financial Risk Levels
Company Sizes for Overall Financial Risk Status 2012-2016

25% of all respondents were financially categorized as moderate/elevated or high/severe risk

Financial Impacts
Self-Assessed Financial Impacts Experienced Due To The End of C-17 Program

- No Change: 267 respondents
- Negative Impact: 102 respondents
- Unknown: 48 respondents
- Positive Impact: 3 respondents

3 respondents indicated that the C-17 program’s closure had a positive effect on their business.

Negative Impacts:
- “Loss of revenue and jobs.”
  - Medium Business
- “Stock (inventory) became obsolete.”
  - Small Business
- “Unable to pay back loans.”
  - Small Business

Financial Risk Level vs. Financial Impact

Financial Impact Due To Termination of C-17 Program According To Financial Risk Levels

Financial Risk Level vs. Financial Impact
High/Severe Risk and Moderate/Elevated Risk Companies

High/Severe Risk Commonalities:
- 6 out of 7 Respondents have known C-17 support and all production is aircraft-related
- Primary business line is manufacturing
- Locations in different states, Only 2 are in California
- Majority small businesses

Moderate/Elevated Risk Commonalities:
- Majority large businesses
- 44% stated C-17 termination had a negative impact on their business
Capital Expenditures Reporting
Number of Respondents with Capital Expenditures 2012 - 2016

26% (110) of respondents had no capital expenditures

Over 50% (55) with no capital expenditures were small businesses

No Capital Expenditures, 110, 26%
Capital Expenditures, 310, 74%

Average Capital Expenditures increased by 54% from 2012 to 2016.

Capital Expenditures
Average Capital Expenditures Broken Down By Allocation

Average of Attributable Capital Expenditures
Broken Down By Allocation

Year

C-17
Defense
Aircraft

2012
$25
$27
$248

2013
$30
$306
$479

2014
$331
$604
$681

2015
$23
$341
$700

2016
$20
$393
$799

$ in Thousands

Reduction of USG Defense Spending
Impact of Reductions In USG Defense Spending on Capital Expenditures

16 of the 34 respondents who were negatively impacted are small business enterprises.

“We had no reason for growth. We just needed to survive, and we have so far.”
-Small, Moderate/Elevated Risk Business

“From 2013 through 2015, there was little need for more equipment as government procurement was flat.”
-Medium, Low/Neutral Risk Business

Use of 3D Printing for Obsolescence
Number of Respondents Utilizing 3D Printing To Manage Obsolescence Issues and Aircraft Program Applicability

Q10, C 420 Respondents

Only 7 of the 65 respondents with 3D printing capabilities experienced a decline in aircraft-related capital expenditures due to a reduction in USG defense spending.

None of the 65 respondents who have 3D printing capabilities are classified as high/severe risk companies.

### 3D Printing

#### Top 10 3D Printing Product/Service Categories

<table>
<thead>
<tr>
<th>Product/Service</th>
<th># of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing, Evaluation and Professional Services</td>
<td>16</td>
</tr>
<tr>
<td>Raw Materials and Purchased Parts</td>
<td>12</td>
</tr>
<tr>
<td>Material Processing/Finishing</td>
<td>9</td>
</tr>
<tr>
<td>Communication and Recording Systems</td>
<td>4</td>
</tr>
<tr>
<td>Fuel Systems</td>
<td>4</td>
</tr>
<tr>
<td>Propulsion Systems</td>
<td>4</td>
</tr>
<tr>
<td>Engine Build-Up Assembly and Nacelle</td>
<td>4</td>
</tr>
<tr>
<td>Flight Control Systems</td>
<td>3</td>
</tr>
<tr>
<td>Emergency Systems and Fire Detection</td>
<td>2</td>
</tr>
<tr>
<td>Airframe: Forward, Center and Aft Fuselage</td>
<td>2</td>
</tr>
</tbody>
</table>

Respondents were asked to list up to two products or services which have 3D printing capabilities.

Q10, C

3D Printing
Top 5 3D Printing Product/Service Areas

- U24 - Other Purchased Part: 5
- W9 - Engineering Services: 2
- W10 - Other Testing Service: 2
- F4 - Other Fuel System: 2
- L6 - Other Communication and Recording: 2

Other Systems/Services listed cover a wide array of product and service areas.

Examples include:
- Flight simulators, interior lighting systems, aircraft and engine level fuel components, component testing, and prototyping.

Research and Development
Percent of Respondents That Conduct R&D

- Small: 14% (18 respondents)
- Medium: 33% (43 respondents)
- Large: 58% (91 respondents)

152 of the 420 respondents (36%) indicated that they conduct research and development.

Research and Development
Would Your Organization Conduct R&D if the U.S. Government Provided Funding?

- **Small**
  - Yes: 30%
  - No: 66%
  - Yes but not aircraft-related: 4%

- **Medium**
  - Yes: 41%
  - No: 58%
  - Yes but not aircraft-related: 2%

- **Large**
  - Yes: 44%
  - No: 51%
  - Yes but not aircraft-related: 5%

*Q11, A1* 152 Respondents

Research and Development
Average Small Business R&D Expenditures 2012-2016

Small Business R&D Expenditures have increased by 47% from 2012 to 2016

Research and Development

Average Medium Business R&D Expenditures 2012-2016

Medium Business R&D Expenditures have increased by 29% from 2012 to 2016

Research and Development
Average Large Business R&D Expenditures 2012-2016

Large Business R&D Expenditures have increased by 5% from 2012 to 2016

Q11, B1

Research and Development

Average Annual R&D Expenditure By Area of Research 2012-2016

Year | C-17 | Defense | Aircraft
--- | --- | --- | ---
2012 | 2% | 34% | 63%
2013 | 2% | 34% | 60%
2014 | 2% | 34% | 64%
2015 | 1% | 34% | 65%
2016 | 1% | 35% | 64%


Q11, B2-4

152 Respondents
Research and Development
Average R&D Expenditure By Area of Research and Company Size 2012-2016

Research and Development
Top R&D Funding Sources 2012-2016

- Internal/Self-Funded: 135
- DoD: 12 (Primary), 16 (Secondary)
- U.S. Industry: 4 (Primary), 14 (Secondary), 1 (Other)
- Other: 17
- Other USG: 5
- State and Local Government: 2
- Universities: 1
- Non-U.S. Investors: 1

“Our equipment can be applied to commercial as well as military aircraft part construction, so our R&D efforts are equally applicable to both segments.”
-Large Business

Research and Development
Top Aircraft-Related R&D Funding Sources 2012-2016

Approximately 72% of respondents that conduct R&D utilize their primary source of funding for aircraft-related activities.

Q11, C1

Security Expenditures

Average Aircraft-Related Physical and Cyber Security Expenditures

Security Expenditures
Average Small Business Cyber and Physical Security Expenditures

- **Cyber Security Expenditures**
  - 2012: $2.1
  - 2013: $2.8
  - 2014: $3.4
  - 2015: $3.6
  - 2016: $4.1
  - 2017: $5.8

- **Physical Security Expenditures**
  - 2012: $0.7
  - 2013: $0.8
  - 2014: $0.7
  - 2015: $0.9
  - 2016: $1.0
  - 2017: $0.7


Q12, A

130 Respondents
Security Expenditures
Average Medium Business Cyber and Physical Security Expenditures

Security Expenditures
Average Large Business Cyber and Physical Security Expenditures

Cyber Security Policies

Cyber Security Policies in Place for All Respondents

- Restrict IT Privileges to Specific Employees: 96.0%
- Inventory of Authorized and Unauthorized Software: 78.8%
- Inventory of Authorized and Unauthorized Devices: 78.1%
- Maintain, Monitor, and Analyze Audit Logs: 77.1%
- Written Protocols for Security Breach: 67.6%
- Annual Cybersecurity Training Requirement: 60.7%
- Two-Factor Authentication: 35.2%

Q12, B

420 Respondents

Cyber Security Policies

Cyber Security Policies in Place by Company Size

- Restrict IT Privileges to Specific Employees
  - Small: 89%
  - Medium: 98%
  - Large: 99%

- Inventory of Authorized and Unauthorized Software
  - Small: 62%
  - Medium: 86%
  - Large: 87%

- Inventory of Authorized and Unauthorized Devices
  - Small: 65%
  - Medium: 80%
  - Large: 87%

- Maintain, Monitor, and Analyze Audit Logs
  - Small: 55%
  - Medium: 80%
  - Large: 93%

- Written Protocols for Security Breach
  - Small: 43%
  - Medium: 67%
  - Large: 89%

- Annual Cybersecurity Training Requirement
  - Small: 36%
  - Medium: 56%
  - Large: 85%

- Two-Factor Authentication
  - Small: 24%
  - Medium: 33%
  - Large: 46%

Q12, B


420 Respondents
Cyber Security Policies

Cyber Security Policies in Place By Company Size

<table>
<thead>
<tr>
<th>Cyber Security Measures</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restriction Against Non U.S. Storage of CSI</td>
<td>71%</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>Data Exfiltration Safeguards</td>
<td>54%</td>
<td>67%</td>
<td>71%</td>
</tr>
<tr>
<td>Encrypt CSI Transmitted Externally</td>
<td>44%</td>
<td>64%</td>
<td>77%</td>
</tr>
<tr>
<td>Encrypt CSI in Storage</td>
<td>34%</td>
<td>50%</td>
<td>53%</td>
</tr>
<tr>
<td>Encrypt CSI Transmitted Internally</td>
<td>27%</td>
<td>34%</td>
<td>56%</td>
</tr>
</tbody>
</table>

Outreach and Assistance

Effectiveness of Assistance from Outside Organizations

<table>
<thead>
<tr>
<th>Type of Organization</th>
<th>Very Effective</th>
<th>Somewhat Effective</th>
<th>Neutral</th>
<th>Not Useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Government</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>State and Local Government</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both Government and Industry</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Non-Profit</td>
<td>4</td>
<td>14</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>41</td>
<td>43</td>
<td>15</td>
<td>3</td>
</tr>
</tbody>
</table>


Q13, B

420 Respondents
Outreach and Government Programs
Top 10 Government Programs selected by Organization’s Interest

- Market Expansion/Business Growth: 19.0%
- Cybersecurity: 17.9%
- Continuous Improvement/Lean Manufacturing: 17.6%
- Government Procurement Guidelines: 13.3%
- Export Licensing (ITAR/EAR): 13.3%
- Supply Chain Organization: 12.9%
- Quality Management and Control: 11.7%
- Vendor/Material Sourcing: 10.7%
- Technology Acceleration: 10.0%
- Design for Manufacturability: 8.8%

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