



2018

# Boeing Additive Manufacturing

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# About Boeing



## COMMERCIAL AIRPLANES

Boeing 7-series family of airplanes leads the industry



## DEFENSE, SPACE & SECURITY

World's largest manufacturer of military aircraft and satellites and major service provider to NASA

Large-scale systems integration, networking technology and solutions provider



## GLOBAL SERVICES

A dedicated services business focused on the needs of global defense, space and commercial customers



# \$93.4 BILLION

in 2017 revenues

Products and services support to customers in more than  
**150 COUNTRIES**



Manufacturing, service and technology partnerships with companies around the world

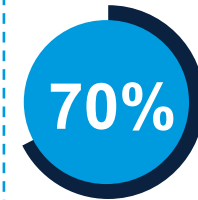
Contracts with more than  
**20,000** suppliers and partners globally

Approximately  
**140,000** BOEING EMPLOYEES

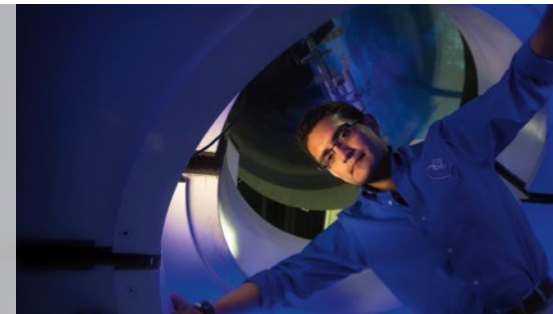


across the United States and in more than  
**65 COUNTRIES**

Research, design and technology-development centers and programs in multiple countries



70% of commercial airplane revenue historically from customers outside the United States



Partnering across the planet for mutual prosperity – and to change the world



# Boeing Additive Manufacturing by the Numbers

**20**

Number of Boeing sites worldwide  
With 3-D printing facilities (U.S.,  
Canada, Australia & U.K.)



**17** U.S. Site Locations

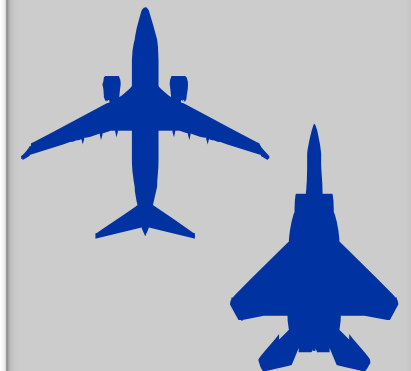


**3 Focus Areas**



**60,000+**

3D-printed parts  
flying on both  
commercial and  
defense  
programs



**Over 20 Years of Experience in Additive Manufacturing**

# Boeing Additive Manufacturing

## Vision

Aerospace **Leader** in Additive Manufacturing

## Mission

**Leverage & Accelerate Additive Manufacturing** in the design & manufacture of parts & tools across the enterprise to transform the production system & support growth

## Strategic Goals



GENERATE DEMAND



BUILD CAPABILITY



PRODUCE PRODUCT



GENERATE, LEVERAGE, & PROTECT IP

## Operational Priorities

- Prioritize Cost Opportunities
- Design for Performance
- Right – Size Capacity
- Global Competitive Benchmarking
- Capture Value

**Leverage Intellectual Capital of our Talented Global Team**

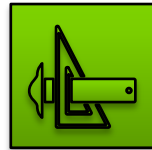


# Boeing Additive Manufacturing

## Technology

## Value Capture Opportunity

Powder bed fusion - metals



Massively reduce detail count for parts made from expensive materials; tooling cost reduction; requires fundamental re-design

Wire fed directed energy deposition (Ti wire)



Improving material yield on high buy-to-fly, titanium end parts by substituting material that is 'only 2x' the cost

Material extrusion (FFF) and SLS



Reduce time and cost of tooling

**Harvesting Available Technology to Create Innovative Processes**

# Boeing Additive Manufacturing Metallic



**2001**

## **X-37A**

- First Flying Laser Additive Manufacturing Part (LAM)

**2003**

## **F15 Pylon Rib**

- Additively Manufactured Ti replacement (LAM)
- Implemented on 15 Aircrafts

**2004**

## **C17 Pylon Panels**

- Additively Manufactured Ti replacement (LAM)
- 41 Articles Installed

**2011**

## **MAI Satellite Components**

- ARCAM - supplied to L-M under MAI
- Launched August 5<sup>th</sup>, 2011

**2016**

## **702 MP Satellite**

- Receive Antenna Deployment Actuator (RADA) Cage

**June 2017**

## **787-9 Passenger Floor Galley Diagonal Fittings**

- First Flying Ti Wire Feed Additive Manufacturing Part

# Boeing Additive Manufacturing Ecosystem

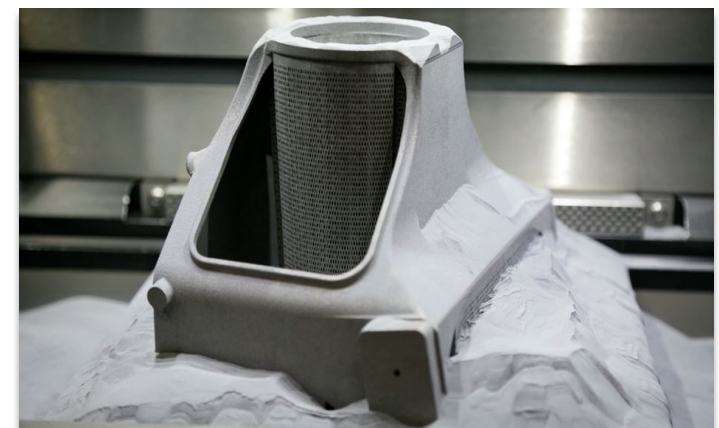
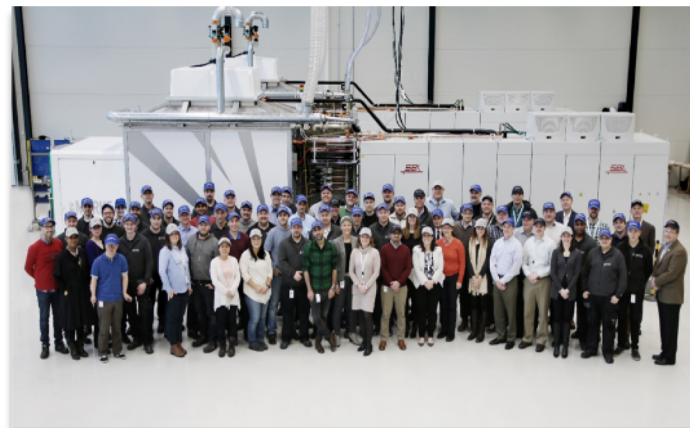
Metal & polymer parts & tooling



Robust, agile supply chain & internal capability

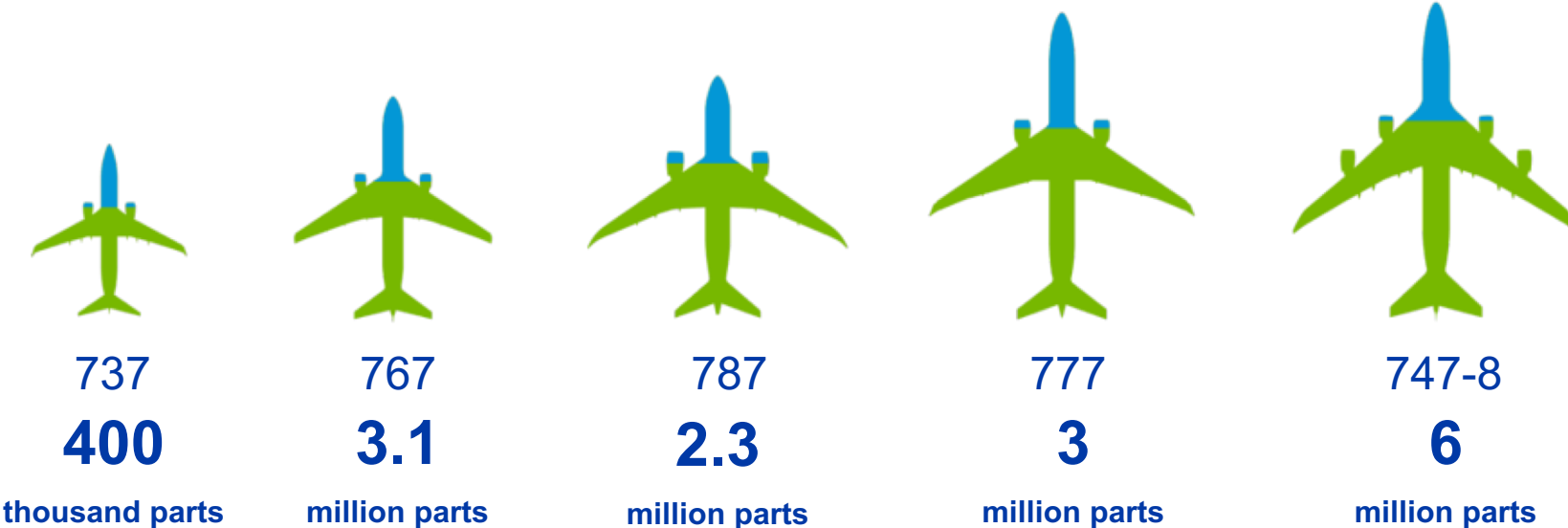


Multiple sources of technology, equipment and materials





# Working with our supply chain partners to succeed together



**65%**

of our airplanes' cost comes through the supply chain

Spending \$43 billion annually • Buying +1 billion parts every year  
~3 million parts arriving at Boeing factories every day  
5,400 supplier factories • 500,000 supplier employees

# Boeing Additive Manufacturing Supply Chain Opportunities



## Structures

- Major assemblies
- Body sections
- Movable wing sections
- Doors
- Flight control surfaces
- Fuselage



## Systems

- Avionics
- Flight systems
- Hydraulics
- Wheels and brakes
- Landing gear
- Environmental control systems
- Electrical systems



## Interiors

- Passenger seats
- Cabin systems
- Galley inserts
- Interiors
- Cargo systems



## Services

- Spares
- Technical & Engineering services
- Customer support
- Internal
- Non-production



## Common Commodities

- Machined parts
- Sheet metal parts
- Assemblies
- Tubing
- Wiring
- Tooling
- Raw materials
- Standards



## Propulsion

- Engines
- Struts
- Nacelles

