



MSC&O

Manufacturing, Supply Chain & Operations

A large blue background graphic featuring a grid of hexagonal patterns. Several hexagons are highlighted with glowing blue borders and contain small, colorful photographs of Boeing employees in various work settings, including manufacturing and office environments.

Build Your Future Here

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Commercial Airplanes

- Boeing 7-series family of airplanes leads the industry
- 806 aircraft deliveries
- 70% of commercial airplane revenue historically from customers outside the United States



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
- Manufacturing, service, and technology partnerships with companies around the world



Global Impact

- 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

About Boeing



Site Locations

- 20 Boeing AM sites worldwide including US, Canada, Australia, and UK
- Multiple innovation cells nationwide



Focus Areas

- Tooling
- Fly-away parts
- Interiors



Programs

- 70,000+ 3D-printed parts flying on both commercial and defense programs
- More than 20 years of experience in Additive Manufacturing

By the Numbers

Technology

Value Capture Opportunity

Powder bed fusion—metals

Massively reduce detail count for parts made from expensive materials; reduce tooling cost; requires fundamental redesign



Wire-fed directed energy deposition (Ti wire)

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



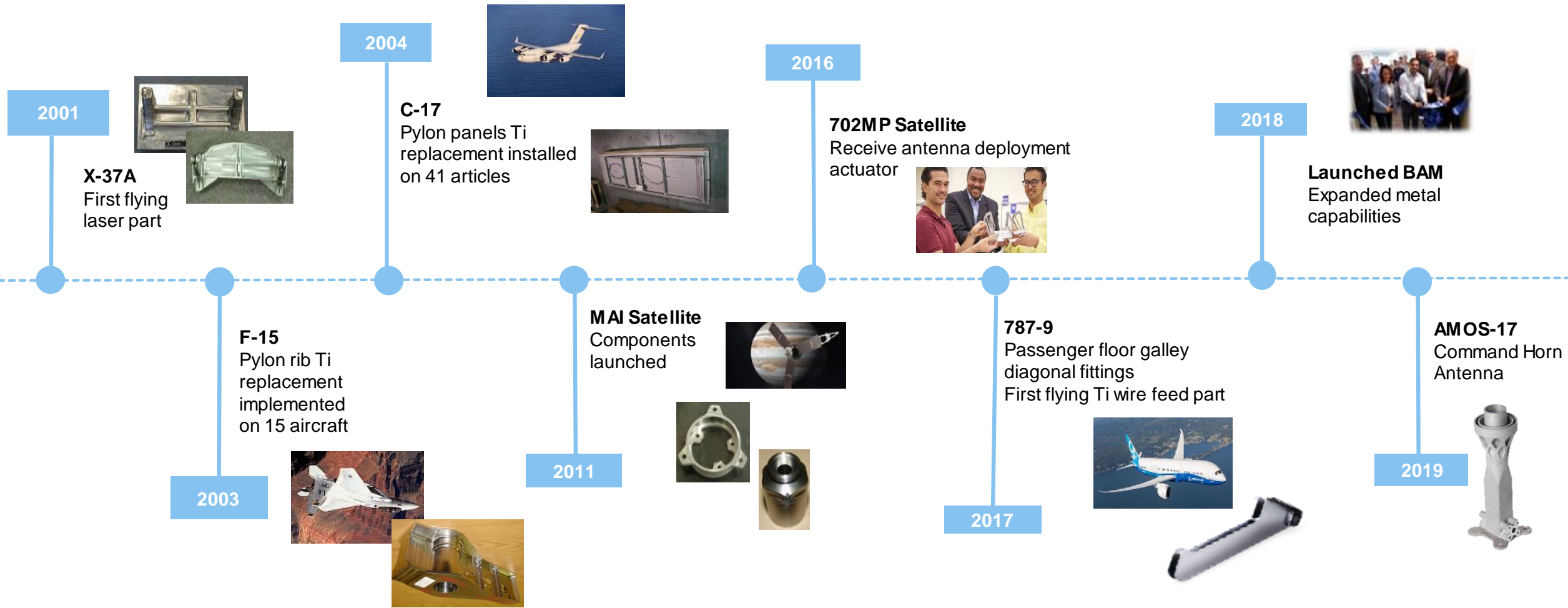
Material extrusion (FFF) and SLS

Reduce time and cost of tooling



Harvesting Available Technology to Create Innovative Processes

Metallic TimeLine

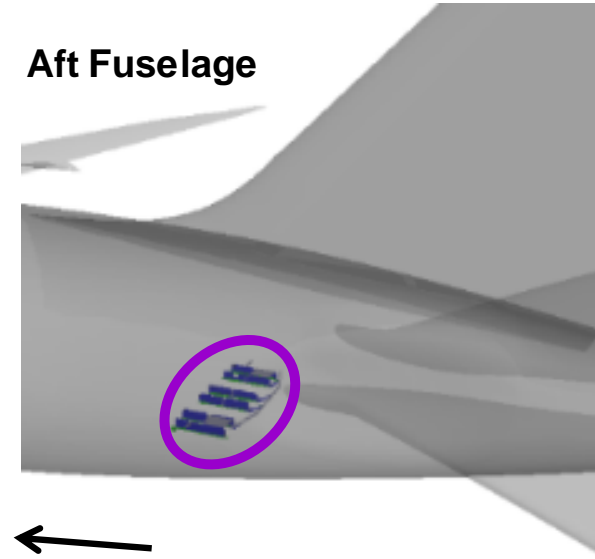


Design Overview: Initial Part Implementation

787-9 Passenger Floor Galley Diagonal Fittings



Aft Fuselage



←
FWD

Means of Compliance

§25.613 Material Design Values & §25.619 Special Factors

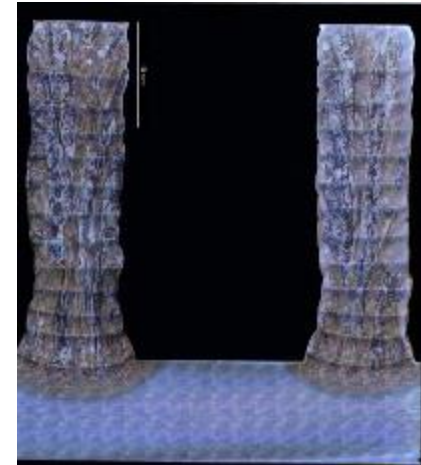
■ Preform Testing Activities

- Fabricated multiple part production runs for testing prior to directly testing deposited preforms from multiple wire lots
- Utilized documented BCA procedures and statistical methods for wrought products approved by the FAA to develop design values
- Demonstrated the ability to use the same analysis methods relative to that used for original 787-9 type certification

■ BMS7-361 spec separately defines required supplier, machine and preform qualification testing

■ §25.619 Special Factors

- *Requires special factor of safety (§25.621 – §25.625) be applied “for each part of the structure whose strength is – (a) Uncertain; (b) Likely to deteriorate in service before normal replacement; or (c) Subject to appreciable variability because of uncertainties in manufacturing processes or inspection methods.”*
 - Demonstrated to not require a special factor of safety through material testing approaches, process control approaches, inspection methods and lot acceptance testing approaches



Summary

- **Boeing additive manufacturing strategy keys on rational implementation consistent with expanding process knowledge**
- **Initial implementation - 787-9 Passenger Floor Galley Diagonal Fittings**
 - Intentional selection of non-critical parts for initial application
- **Compliance shown to FAA requirements**
 - BMS 7-361 material & process specification controls
 - Material design values developed based on coupon test program
 - Means of compliance consistent with original 787-9 type certification



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