



Additive Manufacturing for the Aerospace Industry:

**A Comprehensive Guide of AM Solutions
from Aerospace Experts at Stratasys Direct**

Innovative Manufacturing Solutions to take on Aerospace Challenges

While the global economy recovers from the COVID-19 pandemic, the aerospace and defense industries continue to seek innovative solutions for their manufacturing challenges. Stratasys Direct Manufacturing has partnered some of the biggest names in the industry to explore new technologies, optimize unique designs, and offer custom solutions to combat these difficulties.

This guide provides information on how to leverage additive in your manufacturing process to accelerate time-to-market, lighten the weight of parts, and strengthen your supply chain.

Supply Chain Challenges - Partner with an agile supplier that offers on-demand part production and digital manufacturing.

As supply chain issues continue to hinder growth industry-wide, aerospace companies are building resilient supply chains to mitigate risk and drive long-term growth. Stratasys Direct offers localized sourcing with on-demand production of complex designs through additive manufacturing (AM) and supporting technologies.

Digital Transformation - Take advantage of digital threads from quote to shipment.

With more and more companies moving towards integration of multiple processes from design to build into a unified environment, Stratasys Direct Manufacturing offers the benefits of AM's place in the Internet of Things (IoT) to enable aerospace companies to address operational challenges. With the ease of [onlinequoting](#) through Stratasys Direct, aerospace companies can produce parts on-demand and reduce the need for physical inventories.

Sustainable Manufacturing - Reduce scrap and material usage with AM parts.

Aerospace companies continue to engage in decarbonization as they adopt new and advanced manufacturing technologies to reduce direct **emissions**. Stratasys Direct offers the benefits of AM technology with build processes that only use as-needed material during production.

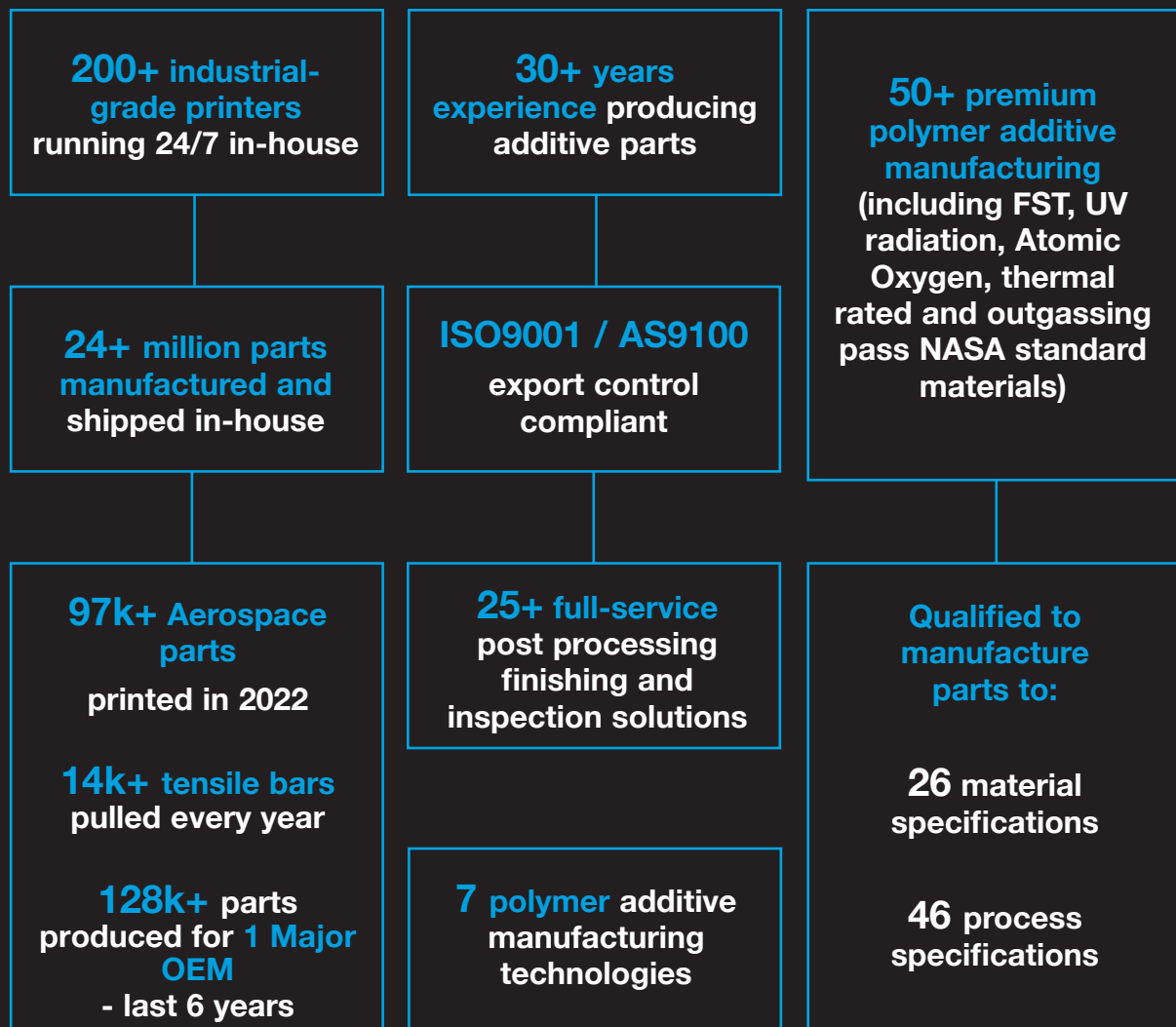
Innovation - Prototype and iterate faster for more fuel-efficient aircrafts.

Aerospace companies were some of the first to adopt additive manufacturing. Stratasys Direct continues to meet innovative ideas with custom solutions and fast iteration speeds. As technology has advanced, aerospace companies can now take advantage of that same production speed for end-use, flight-ready parts.



Partner for Aerospace Applications

Stratasys Direct is a leader in delivering specialized, high requirements projects for the Aerospace industry, providing full material and parts traceability. Our team has more than 30 years of additive manufacturing (AM) experience utilizing high-performance materials formulated for aerospace environments along with a robust ISO9001 / AS9100 process-based QMS. Stratasys Direct has one of the widest offerings of in-house additive technologies, with 7 different options, including Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS) and Programmable Photopolymerization P3™ - frequently utilized by the aerospace community.



AM Accelerates Product Development for Aerospace

The aerospace industry was one of the first to adopt additive manufacturing. As a result, it is arguably the most advanced in its level of adoption and the scope of additive technologies it employs. With a relatively low-volume, high-mix production profile, aerospace is an ideal fit for additive manufacturing.

Aerospace companies use additive manufacturing across a spectrum of applications and find huge benefits in the acceleration of the design and product development process, usually at a lower cost than traditional methods. Additive manufacturing enables this in several ways:

Faster Speed to Part

Because 3D printing is a toolless process, there is no tooling lead time or machining queue to wait for. That means designs can be turned into physical objects much faster, usually in hours or days vs. weeks.

Multimaterial and Multicolor Printing

Certain 3D printing technologies can combine multiple materials and colors in a single printing process. This allows for the creation of prototypes and concept models that closely mimic the final products, eliminating the need for multiple steps typically required in traditional manufacturing methods.

An added benefit of using AM is achieving a better final design. Because parts are made quickly, there is more time for design iteration – trial and adjustment – resulting in a more optimal design than what's possible using traditional prototyping methods.



General Atomics' SkyGuardian aircraft features 240 AM parts, saving \$2 million in tooling costs and achieving more than \$300,000 in recurring costs.

Savings in Tooling

\$2 Million

How AM Benefits Production Support

Production support involves anything associated with the manufacturing process on the production floor. The predominant application of 3D printing in this phase consists of the tooling used to make, assemble, paint and inspect parts.

The key benefit of AM for manufacturing is a lower-cost, more efficient production process. This is possible for the following reasons:

Faster Tool Production

Just like 3D printed prototypes, 3D printed tools offer significantly faster production times compared to traditional manufacturing methods. This is due to the minimal lead time required, unlike the time-consuming processes involved in conventional tool production.

Minimal Operational Disruption

With faster and on-demand fabrication, you can deploy tooling when you need it. This prevents production delays that often arise from the lead times required to manufacture or procure new tools, or to replace damaged tooling.

Easier Ergonomic Designs

AM's design freedom enables the creation of optimized tool designs that perfectly suit the worker and the task at hand, eliminating the need for compromising on tools designed solely based on manufacturability constraints.

Increased Task Efficiency

Optimized tools that streamline operational tasks result in a more efficient process. Reducing repetitive tasks by even seconds adds up to significant time savings over weeks and months.

High-Performance Polymers

Polymers can replace metal in many tooling applications due to their outstanding mechanical performance, resulting in lighter tools. This reduces worker fatigue and repetitive motion injury for hand-held tools.



Boom Supersonic produced multi-hole drill guides using FDM technology for the XB-1 demonstrator aircraft and saved time and cost replacing the metal drill guides.

Up to
Cost Savings **92%**

How AM Benefits End-Use Part Production

Additive manufacturing is traditionally viewed as a prototyping and tooling technology. However, the reality is that AM can beat traditional manufacturing for making flight parts in specific scenarios. These scenarios are becoming more prevalent as aerospace companies increase customization and search for more economical ways to support spare, replacement, and obsolete parts. These situations involve reduced part quantity demand, which opens the door to economically viable low-to-mid-level production quantities using additive manufacturing.

Lighter Parts	Spare Part Availability	Material Characteristics
Additive manufacturing has the ability to produce lighter parts by using lighter materials where possible (polymer vs. metal) and through optimized design methods. Every pound of weight that can be eliminated from flight vehicles means lower fuel consumption and a step towards decarbonization.	Legacy aircraft programs for commercial and defense equate to increased costs as parts become obsolete and new sources for these parts must be found. AM plays a key role by offering parts on-demand locally. This is a more efficient economic model than holding expensive inventories, and allow companies to develop a “digital inventory” instead.	Stratasys Direct offers polymer materials that satisfy a diverse set of application requirements within aerospace. Engineering thermoplastics and carbon-filled materials address the need for prototyping and strong tooling needs. High-performance polymers like ULTEM™ resins meet flight-part criteria for physical and mechanical properties. Antero ESD meets low-outgassing and electrostatic dissipative requirements needed for spacecraft.



By outsourcing Laser Sintering from Stratasys Direct to manufacture the defog duct nozzles for their 412 program, Bell Helicopter realized a weight savings of 13%.

Cost
Avoidance

\$120K

Lead Time
Compression

75%

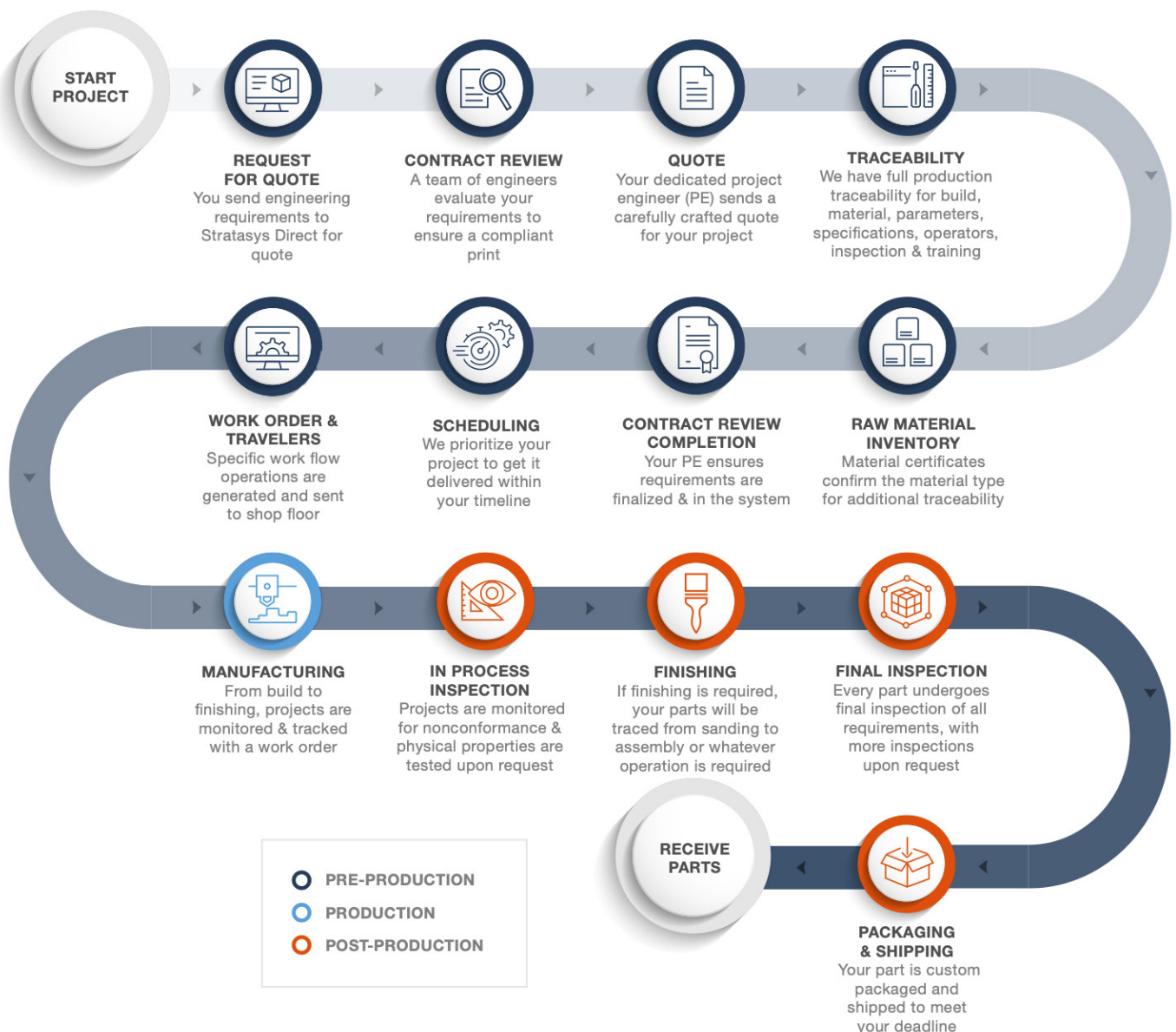
Control and Traceability Throughout the Manufacturing Process

Additive manufacturing has revolutionized aerospace production, but it requires more than pressing a button. Stratasys Direct has over 30 years of experience providing 3D printing technologies to aerospace companies. We hold ISO 9001 and AS9100 certifications, ensuring compliance with customer and regulatory requirements across 26 process and 45+ material specifications.

Our world-class Quality Management Systems guarantee superb process controls for all parts. We deliver **hundreds** of thousands of high-performance components each year, providing expert support to the aerospace industry.

Project tracking, control, and traceability are crucial to our manufacturing controls. From file to delivery, we maintain meticulous traceability of every part's location and movement. We track orders, parts, raw materials, and implement part serialization. This ensures customer satisfaction and operational efficiency.

Below is an example of the control and traceability process we follow to ensure tight controls for production parts.

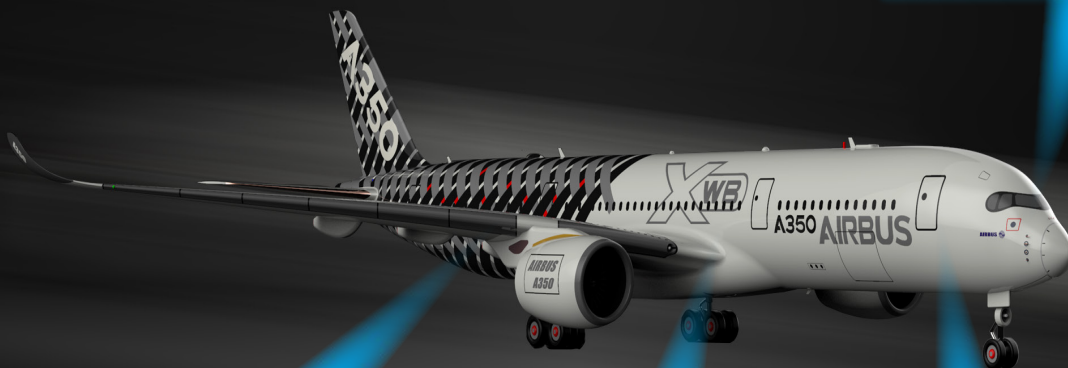


Key Applications

Airplane Commercial and Defense

Flight-worthy Parts

- Electronic cooling duct
- Defog airduct
- Environmental control system ducting
- Filter boxes / connectors / reducers
- FOD barriers
- Wire guides / conduits
- Electrical connector / wiring blocks
- Clips and clamps
- Hydraulics supports / stand offs
- Component connectors
- Camera / gimbal mount
- Air Intake plenum / manifolds
- Brackets / covers
- Spacer C
- Microvanes
- Drain fairing
- Gaskets
- Plated production parts



Key Applications

Remote Piloted Aircraft

Flight-worthy Parts

- Payload enclosures / attachments
- Conformable fuel tank
- Shrouds and closeouts
- Wing structures
- Battery compartment
- Oil tank / glycol / hydraulic fluids
- Aileron flaps
- Avionics and radio closures
- Aerodynamic surfaces
- Connectors / reducers
- Wire ways / conduits / connectors
- Clips / clamps / grommets
- Hydraulics supports and stand offs
- Fuselage components
- Component connectors
- Air filter boxes / air ducting
- External camera and gimbal
- Air Intake manifolds
- Brackets
- Mounting for PODS / avionics and electrical systems



SLS Complex ducting



Conformable SLS gas tank



ECS reducer duct



Intake manifold



Aileron flap

Key Applications

Helicopter / Commercial and Defense

Design & Engineering

- Engineering models / fit test
- Assembly / repair
- Drill blocks/guides
- Router template
- Layup tools / molds / trim fixtures
- Printed tools for bonding structures
- Painting / overspray fixture
- Skunk works / model shop

Manufacturing

- FOD barrier / protection
- Clips and clamps
- Electrical connector
- Wiring blocks/guides
- Hydraulics supports and stand offs
- Fuselage components
- Component connectors
- Air filter boxes / ECS ducting
- Connectors / reducers



Cabin Interiors / Flight Parts

- Training helmets high end military
- Cabin vents
- Display shroud / closeouts
- Bezels / trim
- Custom cosmetic and decorative components
- Camera adaptors
- Interior door latch components
- Storage bin dividers
- Defogger windshield and duct nozzles
- Cup holder
- Canopy latch mechanism
- External camera and gimbal
- Micro vanes
- Air Intake manifolds
- Trim & drill guideasking

Take the Next Step

Thousands of hours testing. Over thirty years of customer-led innovation. We work with leaders in aerospace, like you, revolutionizing the manufacturing process, one 3D printed component after another.

Maximizing Manufacturing Efficiency

Stratasys Direct maximizes manufacturing efficiency using seven 3D printing technologies in-house. We empower our customers to create prototypes, manufacturing tools, and end-use parts that meet their needs, offering enhanced performance, high-temperature resistance, and improved ergonomic properties. Our ability to print parts on demand ensures aerospace components are available when you need them, eliminating delays and optimizing productivity.

97,000+ flight-ready parts printed in 2022

14,000+ tensile bars pulled every year

325,000+ contract projects to date

128,000+ parts produced for one major OEM over the last 6 years

In addition to our broad range of additive manufacturing technologies, we offer design for manufacturing expertise, 50+ engineering-grade materials, aerospace engineering expertise, and 25 material and 46 process specifications to meet the most complex projects. Through close collaboration with leading aerospace companies, we are paving new paths and shaping the future of manufacturing.

[Download our design guides and material guides](#) for more information on Stratasys Direct's tips for our suite of advanced manufacturing technologies.

[Contact a Stratasys Direct expert](#) to learn more about how Stratasys Direct can find custom solutions for your upcoming projects.

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