PRESCOUTER

LIGHTWEIGHTING IN THE AEROSPACE & DEFENSE SECTOR

Innovations in materials and design are leading to key improvements



Executive summary

Lightweighting in aerospace and defense is driving innovation in design and new product development. These innovations are being fueled by new advances in manufacturing and materials science and are leading to key improvements for customers in this industry.

Notable improvements include:

- Weight reduction of parts/components by up to 70% through the use of 3D metal printing technologies or by leveraging novel SiC fibers
- Use of aerogels reducing weight by up to 15% and leading to 50% better thermal insulation than foams and 1000X better soundproofing properties
- New design of aerospace vehicles incorporating carbon fiber materials, leading to 30% weight reduction

MATERIALS

3D SYSTEMS



Company Overview

3D Systems, headquartered in South Carolina, United States, was established in 1986. The company, with 1995 employees, generated a revenue of USD \$557.24 million in 2020.

3D Systems specializes in the innovation of additive manufacturing for the aerospace and defense industry using 3D printing. It has a broad portfolio of hardware, software, and material solutions spanning from plastics to metals.

It provides parts and components to the aeronautic and defense sectors that aim to reduce weight, improve functionality, and consolidate parts to increase fuel efficiency.



Website: <u>3D SYSTEMS</u> Contact: +1 888.598.1438 HQ: United States Company size: 1995



Technology type/element it makes lighter

3D printing using aluminum, maraging steel, steel, nickel and cobalt-chrome alloys, and various grades of titanium



Lightweight percent/amount achieved

Advanced direct metal printing producing lightweight aerospace parts, which reduces weight (up to 70%), improves functionality, and consolidates parts.



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Technology maturity



Application

Aerospace & Defense, Automotive industries

3D SYSTEMS



Technology Details

Titanium alloy confers high ductility and extreme temperature and corrosion resistance. The LaserForm Ti is a lightweight (density 4.42 g/cm³, or 0.159 lb/in³) material for high-strength components as required for a broad scope of parts in aerospace.

Aluminum alloys (e.g., silicon and magnesium) result in increased strength and hardness. In the aerospace and automotive industry, aluminum alloys are used for their lightweight (density 2.68 g/cm³, or 0.097 lb/in³) and specific heat exchanger applications.



Figure. LaserForm Ti Gr1 (A) and LaserForm AlSi12 (B). Source: <u>3D Systems Materials</u>

3D SYSTEMS



Additional Information

The use of metal alloys during 3D printing is ideal for aerospace and defense applications because this method can shape any desired metal part geometry with no need for tooling (e.g., machining, stamping, die casting).

It also has the advantage of providing freedom in design aiming to manufacture lighter parts.

Companies offering 3D printing claim that metal direct printing offers not only durable parts but also stronger parts.

Partnerships: OEM partners





3D SYSTEMS



In the news:

May, 2021: 3D Systems announced two targeted investments to address expanding opportunities for AM in medical and industrial applications. The acquisitions were Allevi, Inc. to expand their regenerative medicine initiative and Additive Works GmbH, a German software firm, to expand simulation capabilities for rapid optimization of industrial-scale 3D printing processes.

September, 2021: 3D Systems announced an agreement to acquire Oqton, a software company creating a new breed of intelligent, cloud-based Manufacturing Operating System (MOS) platform.

October, 2021: 3D Systems announced the acquisition of Volumetric Biotechnologies, a Houston-based biotech company developing the ability to manufacture human organs using bioprinting methods.

^{1.} https://www.3dsystems.com/?ind=aerospace

^{2.} https://www.3dsystems.com/aerospace-defense

^{3.} https://www.dnb.com/business-directory/company-profiles.3d systems_corporation.6464a205483f0d73016d8723bbd3e87f.html

^{4.} https://www.3dsystems.com/press-releases/3d-systems-announces-acquisition-volumetric-biotechnologies

^{5.} https://www.3dsystems.com/press-releases/3d-systems-announces-two-strategic-growth-acquisitions

^{6.} https://www.3dsystems.com/press-releases/3d-systems-drive-adoption-additive-manufacturing-production-environments-acquisition

Airloy Ultramaterials

Aerogel Technologies



Company Overview

Aerogel Technologies, headquartered in Boston, MA, was founded in 2004. It designs and produces aerogels for aviation, defense, commercial scale transportation, automotive, construction, and healthcare applications.

Aerogel Technologies has a strong IP portfolio, with 12 patent families, 27 pending patents, and 13 licensed patents, including NASA's x-aerogel/polymer-crosslinked aerogel and mechanically strong polyimide and polyamide aerogels for monolithic forms.

The company owns a 100,000-sq-ft facility for manufacturing large, mechanically strong aerogel panels.



Technology type/element it makes lighter

Nanoporous ultralightweight and ultrahigh porosity material made of nanomaterials and polymeric fibers



Lightweight percent/amount achieved

3-15X lighter than plastics/composites (~ 0.2 g/cm3, or >99% porosity), 50% better thermal insulating than foams and 1000X better soundproofing properties

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Technology maturity



Application

Aerospace & Defense, Automotive, and Construction industries



Website: <u>Aerogel Technologies</u> Contact: <u>Contact form</u> HQ: United States Company size: 12

Airloy Ultramaterials

Aerogel Technologies



Technology Details

- Excellent mechanical, thermal, and acoustic properties (in 0.06 to 0.55 g/cm³ densities)
- Low thermal conductivity (≤ 20 mW/m-ØK)
- Provides 10-35 dB/cm sound transmission loss (up to 1000X that of any other soundproofing material)
- Operates in high temperatures (≤400°C) in air
- Non-flammable
- Machinable and thermoformable (adaptable curvature and other part features)
- Hydrophobic and moisture-proof
- Energy absorbing material (up to 190 J/g)



Figure. Airloy Ultramaterial vs Plastic. Source: <u>Aerogel Technologies</u>

Airloy Ultramaterials

Aerogel Technologies



Airloy Ultramaterials is a polyfunctional lightweight composite material.

Airloy Ultramaterials can be used to replace interior features (e.g., overhead bins, tray tables, wall linings), as thermal insulators and noise dampeners.

It could reduce 20% of the current weight of a Boeing 737-300, saving up to 3500 lbs of gas per flight.



Partnerships:



Aerogel Technologies



In the news:

December, 2021: Aerogel Technologies was selected by NASA to commercialize a new form of aerogel that is ultrathin, flexible, and dust-free, with applications ranging from 5G antennas to apparel to transportation.

^{1.} http://www.aerogeltechnologies.com/about/our-company/

^{2.} https://youtu.be/s2PiK5vPlhk

^{3.} https://www.nature.com/articles/s41598-021-90101-0

^{4.} https://doi.org/10.1007/978-3-319-73255-8_5-1

^{5.} http://www.aerogeltechnologies.com/worlds-first-pilot-plant-for-manufacturing-ultralight-high-strength-aerogel-panels-and-films-in-large-sizes-to-be-built-in-boston/

^{6.} https://www.prweb.com/releases/thin_is_in_nasa_selects_boston_based_aerogel_technologies_to_commercialize_its_flexible_superinsulating_aerogel_thin_films/prweb17067182.htm

AlXal

ALVANT

Alvant

Company Overview

Alvant Ltd. is headquartered in Basingstoke, United Kingdom. It was founded in 2012, and is part of the alumina and aluminum production and processing industry. Alvant has 15 employees at its UK location and generated \$0.7 million in sales in 2020.

Alavant invests in research and development activities aiming to understand the behavior and performance of industrial aluminum matrix composite materials. It has a strong IP portfolio for the advanced liquid pressure forming technology developed to manufacture metal matrix composites.



Technology type/element it makes lighter

A lightweight high-strength aluminum composite with mechanical, thermal, and electrical properties



Lightweight percent/amount achieved

Alvant's links and strut solutions can reduce the weight of structural metallic components by up to 40%



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Technology maturity



Application

Aerospace & Defense, Automotive, and Construction industries



Website: <u>Alvant</u> Contact: +44 (0)1256 477741 HQ: United Kingdom Company size: 25

AlXal

ALVANT

Alvant

Technology Details

AlXal is a versatile aluminum composite obtained with an advanced liquid pressure forming technology that uses aluminum as the matrix combined with a high-strength reinforcement fiber, which creates a high-performance aluminum matrix composite material.

AlXal can be tailored to control mechanical, thermal, and electrical properties.

It is a lightweight material (40% lighter than titanium with equivalent strength) with adequate fatigue (100X increase in fatigue life versus aerospace-grade aluminum) and damage tolerance.

AlXal is used to produce link and strut solutions in helicopter underslung load equipment and helicopter rotor mechanisms.



Figure. Alvan't Links and Struts technology (above); Interior permanent magnet rotor (below). Source: <u>Alvant Applications</u>





ALVANT

Additional Information

AlXal has many advantages as a structural material with high strength and stiffness, good damage tolerance and fracture resistance, as well as manufacturability properties.

New classes of aluminum metal matrix composites are targeting long-term applications that require saving weight, such as robotics, high-speed machinery, high-speed rotating shafts, and automotive engine and brake parts.



Partnerships:







ALVANT



In the news:

March, 2021: Alvant signed a Memorandum of Understanding with a view to furthering a strategic partnership with advanced materials technology company 3M to accelerate development of its capabilities and find real world applications.

November, 2021: Alvant's developmental work has uncovered AlXal's compatibility with rotor sleeve applications, owing to its preferential electromagnetic, mechanical performance and thermal conductivity for electric motors.

1. https://www.alvant.com/technology/

- 3. https://www.dnb.com/business-directory/company-profiles.alvant_group_plc.17359d2408d9f7fec1f428242cf60ea5.html
- 4. https://www.lens.org/lens/patent/031-905-884-245-100/frontpage?l=en
- 5. https://www.lens.org/lens/search/patent/list?preview=true&g=Alvant
- 6. https://www.greencarcongress.com/2018/12/20181207-alvant.html
- 7. https://aluminiumtoday.com/news/alvant-forges-partnership-with-3m-to-advance-metal-matrix-composite-technology-for-real-world-applications
- 8. https://www.engineerlive.com/content/lightweight-rotor-sleeve-technology

^{2.} https://www.alvant.com/company/

BLUESHIFT



Company Overview

Blueshift is headquartered in Massachusetts, United States. The company, established in 2013, designs and manufactures lightweight material and thermal protection systems with applications in the automotive, electronics, and aerospace industries.

In 2020, with 140 employees, Blueshift generated \$4.95 million, and it is currently operating a 50,000-sq-ft manufacturing facility and a 10,000-sq-ft technology center, both residing on a 100-acre campus in Spencer, MA.

Blueshift's IP portfolio counts <u>22 active patents</u> featuring the design of polymer aerogels with improved mechanical and thermal properties.



Technology type/element it makes lighter

AeroZero polyimide aerogel film has a density of approximately 0.27 g/cm³ (270 kg/m3, 16.8 lb/ft³)



Lightweight percent/amount achieved

5X less density than other polyimides (1.4 g/cm³)



Technology maturity



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Application

Aerospace & Defense, Automotive, and Construction industries



Website: <u>BLUESHIFT</u> Contact: 1-888-350-7586 HQ: United States Company size: 140

BLUESHIFT



Technology Details

AeroZero is a polymer aerogel that can be integrated into traditional and digital manufacturing.

It is 7-9X less dense (0.15 - 0.20 g/cm³) than traditional polymers.

Its porous structure has a high strength-to-weight ratio when bonded to other materials (e.g., metals, plastics, carbon fiber, fiberglass), and as a composite core, it has a compressive strength of 1.6 MPa at 10% strain and 23°C and 1.2 MPa at 10% strain and 50°C.

AeroZero has a low dielectric constant of 1.15, which is just 0.15 higher than air.

AeroZero has a low thermal conductivity of 37 mW/KM at 23°C compared to the thermal conductivity of air, which is 24 mW/KM.

AeroZero maintains its material strength and durability through the temperature range of -195°C to 300°C.



Figure. AeroZero polymer aerogel rolled thin film and AeroZero laminates. Source: <u>Blueshift</u>

BLUESHIFT



Additional Information

AeroZero is a thin polyimide aerogel film that can be used as the primary insulator in aerospace and defense applications.

AeroZero is produced at 165 micros (0.0065 in) thickness and is still capable of offering adequate thermal stability, chemical resistance, and mechanical properties.

It can be installed in aerospace and defense systems when challenging temperature or space restrictions exist, replacing the use of legacy insulators.

Partnerships:





BLUESHIFT



In the news:

April, 2021: Blueshift announced that it achieved AS 9100D certification, demonstrating that its quality management system (QMS) is in accordance with AS 9100D and ISO 9001:2015 and meets rigorous international requirements.

May, 2021: Blueshift featured on NASA Spinoff: NASA's aerogel material led Blueshift to create a paper-thin insulation called AeroZero for use on Earth. The thin, porous nature of AeroZero – it's 85% air – makes it ideal for electronic applications.

- 2. https://www.blueshiftmaterials.com/wp-content/uploads/2017/12/Blueshift-AeroZero-2017-CorpBroch-2.pdf
- 3. https://www.blueshiftmaterials.com/wp-content/uploads/2021/06/AeroZero-Standard-Film-TDS.pdf

- 5. https://www.blueshiftmaterials.com/applications-and-research/
- 6. https://www.blueshiftmaterials.com/as9100d-certification/
- 7. https://spinoff.nasa.gov/flexible-aerogel-insulation-antennas?web=1&wdLOR=c9BB5C5B6-8DFA-410D-BA16-F06350465466

^{1.} https://www.linkedin.com/feed/update/urn:li:activity:6837103073811341312

^{4.} https://www.blueshiftmaterials.com/

TISICS



Company Overview

TISICS, headquartered in the United Kingdom and established in 2005, develops and manufactures silicon carbide fiber reinforced aluminum and titanium matrix composites that deliver 70% lighter components.

TISICS has 25 employees and in 2020 had an estimated revenue of \$5 million.

TISICS has an important IP portfolio with 15 patents, including the development of silicon carbide fibers in the manufacturing of spline shafts used in the aerospace and electric automotive industries.



Technology type/element it makes lighter

Aluminum (stronger and stiffer than titanium) and titanium composites (stronger and stiffer than steel)



Lightweight percent/amount achieved

Up to 70% weight reduction



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Technology maturity



Application

Aerospace & Defense, Automotive, and Construction industries



Website: <u>TISICS</u> Contact: +44(0) 1252 516 678 HQ: United Kingdom Company size: 25

TISICS

Technology Details

TISICS silicon carbide monofilaments are produced by chemical vapor deposition, in 100 μ m and 140 μ m diameter variants.

TISICS incorporates silicon carbide fiber into a metal matrix to form components and to reinforce metals.

The ceramic fiber provides extremely high strength and stiffness, with little or no variation in performance over the full operating temperature of the component.

The metal composites are designed to provide load transfer through the composite in the final part. The metal composites are lightweight, with mass comparable to that of titanium and aluminum and twice the performance per kilogram.

Titanium composites are stronger than steel, capable of forming robust metallic interfaces, have good fatigue life and damage tolerance through fiber reinforcement, are resistant to corrosion even under harsh environments, and have high thermal stability.



Figure. TISICS Ceramic Fiber and Metal Matrix Composites. Source: <u>TISICS</u>

TISICS

Metal Composites

TISICS



TISICS has the technology to provide lightweight materials delivering 40% weight savings on aircraft landing gear and structures and up to 70% on aero-engine components.

TISICS targets weight reduction, propulsion technology, and aerodynamics of aircrafts, aiming to reduce CO₂ emissions with 3%-5% lower fuel consumption in each system.

TISICS provides metal composites suited to high compressive strength applications and that have a comparable tensile performance to 300 M landing steel but with 50% greater compressive performance at half the mass.

Partnerships:



TISICS

Metal Composites

TISICS



In the news:

January, 2020: TISICS won the Powered Transport Award at the 13th Annual Rushlight Awards ceremony recognizing the team's development work on aircraft landing gear and actuators to reduce the carbon footprint of future aircraft.

April, 2020: UK Research and Innovation (UKRI) announced a £1.2M award to TISICS engineer, Ayantika Mitra, to transform advanced materials manufacturing through digital technologies. The four-year project will develop tools across TISICS' multi-stage manufacturing processes to enable rapid certification and qualification of new lightweight products for spacecraft and aircraft.

January, 2021: TISICS signed onto two UK business support projects that utilize the expertise of two of the leading UK space universities to develop standardized fracture mechanics testing methods and to digitize a key process to reduce both cost and manufacturing energy consumption.

^{1.} https://www.tisics.co.uk/index

^{2.} https://www.tisics.co.uk/space-overview

^{3.} https://www.tisics.co.uk/aero-overview

^{4.} https://www.dnb.com/business-directory/company-profiles.tisics_limited.585c542d51eb7cbc8ca4fbe0a0c14371.html

^{5.} https://www.tisics.co.uk/TISICS-scoops-clean-tech-award

^{6.} https://www.tisics.co.uk/TISICS-engineer-awarded-UKRI-Future-Leaders-Fellowship

^{7.} https://www.aero-mag.com/tisics-signs-up-for-two-sprint-projects/

DESIGN

BELL FLIGHT



× 7

Company Overview

Founded: July 1935, by Larry Bell

First helicopter flew in 1942

Certified the first commercial helicopter in 1946

First tiltrotor flew in 1955

Nearly 60% of helicopters produced are Bell

98% of all helicopter missions were pioneered in a Bell product

8,500+ employees



Technology type/element it makes lighter

The V-280's major components are its carbon fiber wing, prop rotor gearbox, and composite yoke for the rotor hub.



Lightweight percent/amount achieved

Use of composites in honeycomb sandwich configurations, which allow engineers to reduce weight by 30% despite having heavy cabin armor.



Technology maturity



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Application Aviation and Defense



Contact: +1 817 280-2011

HO: Fort Worth, Texas, USA Company size: 8,000-10,000

BELL FLIGHT



Technology Details

The V-280's major components are its carbon fiber wing, prop rotor gearbox, and composite yoke for the rotor hub. The wing is the first use of large-cell carbon core composites — a sandwich of carbon-fiber skins and honeycomb. The hub yoke is laid up from composite fabrics and uses open-face tooling around the edges. The V-280 also has the first all-carbon tiltrotor blade.



Figure. Bell V-280 Valor First Flight. Source: Bell Flight

BELL FLIGHT

Additional Information

The V-280 Valor is one of the fastest military helicopters in the world, with a cruising speed of 280 knots (approx. 322 mph). Eventually, the helicopter will be evaluated against the Sikorsky/Boeing SB-1, which claims a top speed of 250 knots (287 mph).



Partnerships: OEM partners











BELL FLIGHT



In the news:

July, 2020: Becoming available for production as early as 2023, the Bell V-247 is an unmanned aerial system (UAS) combining the vertical lift capability of a helicopter with the speed and range of a conventional fixed-wing aircraft. With the Bell V-247 Vigilant design and capabilities bringing to bear experience from the V-22 tiltrotor and UH-1Y/AH-1Z programmes, they are responsible for capturing V-280 Valor's unmatched design and performance standards.

October, 2021: Bell plans to install a version of the Rolls-Royce-made V-22 Osprey engine in the V-280 Valor— an aircraft the company is pitching in a U.S. Army competition to replace the venerable Black Hawk helicopter. The move dramatically increases the horsepower of the V-280 over the General Electric engines it uses today.

^{1.} https://www.bellflight.com/products/bell-v-280

^{2.} https://www.edrotacultural.com.br/primeiro-voo-do-bell-v-280-valor/?print=print

^{3.} https://compositesmanufacturingmagazine.com/2018/05/bell-v-280-valor-makes-first-cruise-flight/

^{4.} http://nationshield.ae/index.php/home/details/techniques/constant-vigilance-with-the-bell-v-247/en#.Yc3afGjMJPY

^{5.} https://www.defenseone.com/business/2021/10/bell-picks-rolls-rovce-engine-v-280-valor-armv-black-hawk-replacement-contest/185953/

Hybrid Metal/Composite Fan Frame

GKN AEROSPACE



Company Overview

GKN Aerospace develops, builds, and supplies a wide range of advanced aerospace systems, components, and technologies for use in defense and commercial aircraft ranging from helicopters, business jets, and passenger planes to the most advanced combat aircraft. Lightweight composites, additive manufacturing, innovative engine systems, and intelligent transparency reduce aircraft losses and weight and increase passenger comfort. It is a company with 15,000 employees, working in 41 factories in 13 countries.



Technology type/element it makes lighter

Hybrid metal/composite fan frame



Lightweight percent/amount achieved

Weight reduction of components by up to 30%



Technology maturity



Application Aerospace and Aviation



Website: <u>GKN Aerospace</u> Contact: +44 (0) 121 210 9800

HQ: Solihull, West Midlands, USA Company size: 15,000

Hybrid Metal/Composite Fan Frame

GKN AEROSPACE

Technology Details

Replacement of traditional titanium components with lighter carbon fiber composites in large engine parts

GKN manufactures lightweight composite fan housings and fan spacers

It is also developing and validating a hybrid metal composite fan frame, which is expected to reduce component weight by up to 30% when compared to a similar metal solution

Competitive manufacturing techniques such as automated pick-and-place of fabrics or pre-pregs and resin transfer molding are being developed for this part, allowing for significant cuts in manufacturing time.



Figure. Illustrations showing how GNK Aerospace is replacing traditional titanium components with lighter carbon fibre composites in large engine parts. Source: <u>GKN Aerospace</u>



Hybrid Metal/Composite Fan Frame

GKN AEROSPACE

In the news:

October, 2021: GKN Aerospace and KTH will develop electric fan technology for smaller regional aircraft. The project, to span more than 1.5 years, will study aerodynamic design, performance, noise, and manufacturing technology for a nested fan powered by electricity, either from batteries, hydrogen fuel cells, or conventional hybrid propulsion solutions.

December, 2021: As part of the joint FlyZero initiative to achieve zero-carbon air transportation that includes experts from GKN Aerospace, the UK's Aerospace Technology Institute unveiled a concept for a hydrogen-powered midsize, long-haul airliner.



Partnerships:



- 1. https://www.gknaerospace.com/en/our-technology/2017/composite-engine-components-driving-efficiency-in-aviation2/
- 2. https://www.aerospacemanufacturinganddesign.com/article/gkn-aerospace-lead-development-electric-fan-thruster/
- 3. https://www.aerospacemanufacturinganddesign.com/article/gkn-aerospace-lead-development-electric-fan-thruster/
- 4. https://www.ainonline.com/aviation-news/air-transport/2021-12-06/uk-reveals-plans-hvdrogen-powered-long-haul-airliner

GE Aviation



Company Overview

GE Aviation, a subsidiary of General Electric, is headquartered in Evendale, near Cincinnati. GE Aviation is among the largest suppliers of aero engines, offering products mostly for commercial aircraft.



Technology type/element it makes lighter

New engine or aircraft model, GE9X, by 3D printing



Lightweight percent/amount achieved

The GE9X engine, which is lighter and more economical without new production processes.



Technology maturity



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Application Aerospace and Aviation



Website: <u>GE Aviation</u> Contact: +1 888 999 5103 HQ: Cincinnati, Ohio, USA Company size: 48,000

GE Aviation

Technology Details

The GE9X is the most fuel-efficient jet engine GE has ever produced, operating with 10% less fuel consumption than competitive engines

The GE9X engine is in the 100,000-pound thrust class and has the largest 134-inch diameter front fan with a composite fan housing and 16 fourth-generation carbon fiber composite fan blades

3D-printed parts

Lightweight and durable ceramic matrix composite (CMC) material in the combustor and turbine





Figure. GE9X Engine. Source: GE Aviation

GE Aviation

Additional Information

According to GE Aviation, a mix of evolutionary and revolutionary designs will allow the GE9X to be the most fuel-efficient jet engine GE has ever produced per pound of thrust. It is designed to provide 10% better aircraft fuel consumption compared to the GE90 -115B-powered 777-300ER and 5% improved specific fuel consumption compared to any available dual-aisle engine, while achieving a ratio deviation of approximately 10:1, 60:1 overall pressure and margin ratio for Stage 5 noise limits.



Partnerships:







GE Aviation



In the news:

September, 2020: The GE9X engine was certified by the Federal Aviation Administration. To be certified, the GE9X test engines completed just under 5,000 hours and 8,000 cycles. A total of nine test engines were included in the Federal Aviation Regulation (FAR) Part 33 certification.

November, 2021: GE Aviation has completed dust-ingestion testing on its new GE9X engine for the Boeing 777X, as the propulsion specialist eyes a potential third application for the widebody turbofan. Performed at the manufacturer's facility in Peebles, Ohio, the trial saw the 110,000-lb-thrust (489kN)-class powerplant run for a total of 1,600 cycles while a stream of dust particles was injected into the engine.

December, 2021: GE Aviation will become the main focus of the GE conglomerate after it spins off its health care and energy businesses. According to a company press release, "Following these transactions, GE will be an aviation-focused company shaping the future of flight." The company doesn't expect any regulatory or labor issues attending the split, and GE said there was no investor pressure behind the move.

^{1.} https://www.geaviation.com/commercial/engines/ge9x-commercial-aircraft-engine

^{2. &}lt;u>https://www.geaviation.com/press-release/ge9x-engine-family/ge-aviation-powers-first-flight-boeing-777x</u>

^{3.} https://aeromagazine.uol.com.br/artigo/impressao-em-3d-se-torna-padrao-na-aviacao_2035.html

^{4.} https://www.ge.com/news/reports/ge-aviation-partners-win-22-billion-new-deals-farnborough-airshow

^{5.} https://www.geaviation.com/press-release/other-news-information/ge-aviation-and-its-joint-venture-announce-56-billion-deals

^{6.} https://www.aviationtoday.com/2020/09/29/ge-aviation-achieves-faa-certification-ge9x-engine/

^{7.} https://www.flightglobal.com/dubai-2021/ge9x-clears-dust-ingestion-test-milestone/146358.article

^{8.} https://www.airforcemag.com/article/ge-aviation-to-be-standalone-company/

AIRBUS



Company Overview

Airbus is an aerospace company that designs, manufactures, and markets industry-leading commercial aircraft, helicopters, military transport, satellites, and launch vehicles and provides data, navigation, secure communications, urban mobility, and other solutions to customers on a global scale.



Technology type/element it makes lighter

The Zephyr 7 is a high-altitude pseudo-satellite solar-powered ultralight aerobatic UAV aircraft.



Lightweight percent/amount achieved

Higher flight altitude (21,562 m) for UAVs, in part due to increased energy efficiency by reducing weight.



Technology maturity



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Application Aerospace & Defense



Website: <u>AIRBUS</u> Contact: +1 (972) 641 3775 HQ: Leiden, Netherlands Company size: 131,349

AIRBUS



Technology Details

Zephyr is the world's leading solar-electric stratospheric unmanned aerial system (UAS), with a wingspan of 25 m and weighing less than 75 kg, powered by solar energy

Zephyr's low-weight structure allows it to travel non-stop over long distances or to remain airborne in a desired station for a considerable time

The unique propeller design provides the aircraft with a higher power-to-weight ratio

The aircraft flies day and night powered by solar energy – recharging its batteries during the day

No complex launching mechanisms – the aircraft is launched manually by a ground crew of three people

Silent flight – neither noise nor pollutant emissions

The wing design takes into account thermal air currents to lift the aircraft to higher altitudes



Figure. Illustration of the Airbus Zephyr. Source: Airbus

AIRBUS

Additional Information

Airbus also develops the "<u>blended wing body</u>" design featuring a wide cabin layout, which could reduce fuel consumption by approximately 20% compared to current single-aisle models with the same engine. Integration of many other types of propulsion systems is also a possibility, thanks to the spacious configuration, which opens up the design space in new and exciting ways.



Partnerships:

3M

FORMTECH COMPOSITES



KISTLER measure. analyze. innovate.



AIRBUS



In the news:

October, 2021: The Airbus Zephyr S completed a successful 2021 test flight campaign in the United States. The final Airbus solar-powered High Altitude Platform System (HAPS) flight touched down on September 13 in Arizona, USA, ending the most ambitious and successful Zephyr flight campaign to date.

November, 2021: Airbus and NTT DOCOMO, Inc. have demonstrated the ability to use the solar-powered Zephyr High Altitude Platform Station (HAPS) to deliver future wireless broadband connectivity. The trial took place in the United States in August, when the Zephyr S aircraft undertook approx. 18-day stratospheric flights to test various capabilities.

- 4. https://news.satnews.com/2021/10/18/the-airbus-zephyr-haps-reaches-new-heights/
- 5. https://www.airbus.com/en/newsroom/press-releases/2021-11-zephyr-high-altitude-platform-station-haps-achieves-connectivity-in

^{1.} https://www.airbus.com/defence/uav/zephyr.html

^{2.} https://news.satnews.com/2021/10/18/the-airbus-zephyr-haps-reaches-new-heights/

^{3.} https://www.airframer.com/aircraft_detail.html?model=Zephyr

BOEING



Company Overview

The Boeing Company is an American multinational Aerospace & Defense development corporation founded in 1916 by William E. Boeing in Seattle, Washington.



Technology type/element it makes lighter

An improved aluminum alloy is used in the upper wing frame and stringers. This alloy provides greater compressive strength than previous alloys, enabling weight reduction and increased resistance to corrosion and wear.



Lightweight percent/amount achieved

The 777 uses lighter, lower-cost structural materials that reduce the overall weight of the aircraft and contribute to fuel economy.



Technology maturity



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Application Aerospace & Defense



Website: Boeing Contact: +1 312-544-2000 HQ: Chicago, Illinois, USA Company size: 141,322

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BOEING

Technology Details

The 777's advanced wing design, with a 60.9 m wingspan, enhances its ability to reach higher cruising speeds faster

Dual engines – Fuel efficient, quiet, and reliable. The main factors responsible for this performance are the new larger diameter fans, with wide-chord fan blade design and bypass rate ranging from six-to-one to nine-to-one. This is similar to the typical five-to-one rate of engines on older two-aisle aircraft.

Lighter-weight design – Carbon fibers embedded in newly developed hardened resins are found in the vertical and horizontal tails. Other composite applications include secondary structures such as aerodynamic flap mechanisms. Composites, which include resins and adhesives, represent 9% of the 777's structural weight.



Figure. Boeing 777 in flight. Source: <u>Boeing</u> <u>Dreamscape via Wikimedia Commons</u>





The 777 uses lighter, lower-cost structural materials that reduce the aircraft's overall weight and contribute to the 777's fuel economy. An improved aluminum alloy, for example, is used in the upper wing structure and reinforcement spars (stringers). Known as 7055, this alloy provides greater compressive strength than previous alloys, enabling weight reduction and increased resistance to corrosion and wear.



Partnerships:

TORAY Innovation by Chemistry









In the news:

June, 2021: Aerospace giant Boeing is working to send astronauts to space with its CST-100 Starliner spacecraft. The crew space transport spacecraft is being developed in collaboration with NASA's Commercial Crew Program.

November, 2021: Qatar Airways showcased its role as a global launch customer for the latest generation Boeing 777-9 aircraft after welcoming the ultra-modern, fuel efficient jet to Doha International Airport (DIA). The aircraft will be the world's largest and most efficient twin-engine jet, delivering 20 percent lower fuel consumption and emissions than previous generation aircraft.

^{1.} https://www.boeing.com.br/produtos-e-servicos/avioes-comerciais/777.page

^{2.} https://www.airframer.com/aircraft_detail.html?model=B777

^{3.} https://ftnnews.com/aviation/42858-gatar-airwavs-welcomes-first-boeing-b777-9-aircraft-to-doha

About the Authors



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Jorge supports PreScouter as an Advanced Degree Researcher helping provide clients with high-quality information and analysis about the latest insights into disruptive technologies, helping companies find new markets and remain competitive in their market niche. Jorge performs research in developmental and environmental sustainability in both developed and developing countries, using expertise acquired at the Universities of Florida and Syracuse (US), Ryerson, and Environmental and Climate Change Canada. Jorge holds a PhD in Biology and an MA in Conservation Biology.



Nicolis Amaral

Researcher

Nicolis is a Chemical Engineer with a focus on wastewater treatment who holds a Master's in Mechanical Engineering from the Military Institute of Engineering, Brazil, with emphasis in the field of thermofluid dynamics, and a PhD in Chemical Engineering from COPPE - Federal University of Rio de Janeiro, in the area of development of new polymeric processed materials engineering in composite propellants. Nicolis is currently an engineer for a Petroleum Engineering company, supervising oil elevation surveys in onshore wells, and a researcher at the Institute of Nuclear Engineering, where she applies sustainable polymers to the development of nuclear products for cancer treatment. She also serves as an Innovation Consultant at Inteligência Personalização, working in the development of innovation projects for the engineering, product development, and research sectors. Nicolis is passionate about research development for innovation projects.

Potential Next Steps

- PreScouter can conduct anonymous interviews with companies profiled to help you learn more about their technologies, processes, and partnership potential.
- PreScouter can identify the intellectual property position of these players and understand patent trend evolution.
- PreScouter can identify additional suppliers located in specific regions to source products and other services.



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