

THE CURRENT STAGE IN AEROSPACE AT THE END OF 2020

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ABSTRACT

The paper briefly presents some models of aircraft considered avant-garde in 2020, and it is part of the reviews on news in aviation and aerospace. It briefly presents some basic features, news, and more important data for each new model on display, so that the reader can get an image of that model but also an overall one, to compare different models from a particular manufacturer with each other, as well as with those belonging to another manufacturer. Aircraft manufacturers are constantly concerned with modifying their aircraft and building other new models that meet customer requirements as much as possible, but at the same time lead to reductions in total fuel consumption used in flight, to reduce pollution due to flights and the negative effects on planetary ecosystems, as well as the increase in the quality and safety of air travel.

Keywords: Mach 3, New aircraft, Concorde, Aerospace, Aircraft, British Airways

1. INTRODUCTION

The air travel market is growing rapidly, so designers regularly publish concepts for the air transport of the future.

The aerospace giant Airbus tested an unmanned flying taxi created within the Vahana project (Figure 1). The aircraft, called the Alpha One, took off for the first time. The climb was low - only 4.9 m - and Alpha One was in the air for only 53 seconds, after which it landed. However, the aircraft performed all operations independently, in an autonomous manner. The next day, the Vahana project team performed another Alpha One takeoff test and was also successful.



Figure 1: The aircraft called the Alpha One

Source: <https://zizuhotel.ru/ro/rabota-blogerom/innovacionnye-razrabotki-v-sfere-aviastroeniya-innovacionnaya/>

It seems that Airbus has launched the project to "democratize private flights" using all the latest technologies, including automatic vision and electric propulsion. Based on this concept, the Vahana team developed Alpha One, a single-passenger electric take-off, and landing (VTOL) aircraft. The company's ultimate goal is to create a fleet of self-propelled, drone-like passenger drones, which Waymo is set to launch this year, but Airbus is even more ambitious.

However, before this can happen, Airbus must continue to develop its technology and perform more flight tests, after which it can switch to horizontal flight testing.

Lockheed Martin & Aerion

Among the developers of the various equipped equipment, there is a real battle over those who will first launch a supersonic aircraft that will be widely used. And recently, one of Lockheed Martin's biggest producers joined this race with his new supersonic business jet project.

Lockheed Martin is collaborating with Aerion on a new project, and the new aircraft will be named AS2 (Figure 2).

The main innovation in the production of the aircraft will be the design of three engines: two are located under the wings of the aircraft, the third in the tail. This arrangement will positively affect both the speed and aerodynamics of the future airliner. It is worth noting that Lockheed Martin engineers presented such a design in 2014, but only now has found a

worthy application. In addition, the aircraft cabin will be made according to all standards corresponding to the premium segment, and the flight from Los Angeles to Sydney, according to the creators, will take only two hours for the aircraft.



Figure 2: Lockheed Martin is collaborating with Aerion on a new project and the new aircraft will be named AS2

Source: <https://zizuhotel.ru/ro/rabota-blogerom/innovacionnye-razrabotki-v-sfere-aviastroeniya-innovacionnaya/>

The collaboration with Aerion was not accidental. The fact is that this company is one of the market leaders in the design of aerodynamic bodies, which is very important for any aircraft.

The founder of the American company SpaceX, Elon Musk, proposed the use of the promising reusable BFR launch vehicles for passenger flights on planet Earth. According to Musk's tweet, due to such missiles, the flight time between any two points on the planet will not exceed one hour. Today, many aircraft designers are working to significantly reduce flight time. The creation of "quiet" supersonic passenger aircraft is considered to be the main way to accelerate air transport. The first such aircraft should appear in the early 2020s and will reduce flight time on conventional routes by half on average.

According to a presentation posted on SpaceX's YouTube channel, BFR missiles with passenger modules could be launched from offshore platforms. Passengers will be transported there by high-speed ships. After launching and entering orbit, the detachable stages of the BFR rocket would return to the ground, and the passenger module would fly to the target outside the Earth's atmosphere at a speed of 27 thousand kilometers per hour.

Toyota has decided to invest \$ 350,000 in a project to create a flying car. According to NHK, this will help complete the development of the vehicle by 2019. The public premiere of the car may take place as early as 2020 at the Tokyo Olympics. According to preliminary data, the flying machine will be called Skydrive (Figure 3). Several Toyota employees have been working on this project since 2012 on a voluntary basis. The single-seater car will receive four rotors, which will work similarly to modern quadcopters.

The maximum speed of Skydrive will be 100 kilometers per hour. The car will be able to take off at a height of 10 meters. The car will also be able to travel on public roads.

Earlier, it was reported that Toyota intends to create a hovercraft. It was assumed that this solution would reduce friction and, consequently, increase engine efficiency and improve control.

At the moment, several companies are engaged in the development of simultaneous flying machines. So, this year such a vehicle was presented by the Slovak company AeroMobil. The development of the car has been going on for 25 years. At this time, the new product is already available for pre-order. Prices for it range from 1.2 to 1.5 million euros.

It takes three minutes for AeroMobil to automatically enter airplane mode.

The power reserve in the ground version is 700 kilometers, and in the air version - 750.

The maximum speed of the car is 160 kilometers per hour. At the same time, in air mode, this figure reaches 360 kilometers per hour. A vehicle can accelerate to 100 kilometers per hour in 10 seconds. The weight of the car is 960 kilograms.

British billionaire Richard Branson supported the American company Boom in developing a supersonic passenger plane. The day before, the company unveiled a prototype of this aircraft, dubbed the XB-1 Supersonic Demonstrator (Figure 4).



Figure 3: A Skydrive

Source: <https://zizuhotel.ru/ro/rabota-bloggerom/innovacionnye-razrabotki-v-sfere-aviastroeniya-innovacionnaya/>



Figure 4: XB-1 Supersonic Demonstrator

Source: <https://zizuhotel.ru/ro/rabota-bloggerom/innovacionnye-razrabotki-v-sfere-aviastroeniya-innovacionnaya/>

Virgin Galactic from Branson provides financial and technical support for the project. The first test flight of the plane is scheduled for the end of next year, with tests taking place in Southern California.

The prototype presented is a reduced 1: 3 copy of the production model. The aircraft is made of special composite materials, has only 40 standard seats for first-class passengers, which are arranged one by one.

The new supersonic passenger aircraft is expected to cover the distance between London and New York in 3.5 hours, the journey from San Francisco to Tokyo in four hours, and from Los Angeles to Sydney in six hours.

"I have long been passionate about aerospace innovation and the development of high-speed commercial flights. Virgin Galactic is a space innovator and it was easy for them to decide to work with Boom", says Richard Branson.

The innovative core of the world-class domestic aviation industry will be formed at Zhukovsky. This was stated by Russian Prime Minister Vladimir Putin on the MAKS-2011 air show that is taking place these days. It is assumed that this center will include offices and institutes of scientific design, as well as experimental plants.

Russian authorities expect to set up a world-class research and production group of the domestic aviation industry based on the Zhukovsky National Aircraft Manufacturing Center, Russian Prime Minister Vladimir Putin said at the opening ceremony of the 10th International Motor Show of Aviation and Space MAKS-2011.

"Here in Zhukovsky, our National Aircraft Manufacturing Center is being created, which will include offices and scientific design institutes, experimental plants. In fact, based on the center, an innovative core of the domestic aviation industry will be formed, as we expect - global research and production group", - Putin said.

"Modest steps have already been taken in this direction: the road has been built, two bridges - this is the beginning", the prime minister stressed.

Keep in mind that transportation logistics is a big issue for Zhukovsky. Participants in the air show complain that it is quite problematic to get to the venue.

The Prime Minister expressed his hope that "until the next air show, MAKS-2013, the building of the new headquarters of the United Aviation Corporation, as well as other facilities of the National Aircraft Construction Center, will appear here."

Referring to the issue of modernization, Vladimir Putin mentioned that the Russian authorities will continue to support the Russian aerospace complex, which is a strategic priority for the country.

"The state has offered and will continue to provide support to the Russian aerospace complex. This is an absolutely strategic priority for us", Putin said.

According to him, only in 2009 - In 2011, more than 270 billion rubles were allocated for the development of the aviation industry.

"After the level of annual spending on space exploration, the country has become the fourth in the world in terms of absolute volumes of investment", - added the Prime Minister.

He noted that even in times of crisis, it was possible to ensure the promotion of all key projects with which the future of astronautics is connected, as well as civil and military aviation.

Putin said that Russia is returning to research programs for the planets of the solar system, increasing the Russian orbital constellation, including satellites of the GLONASS system.

"We are actively working on the MC-21 aircraft project, this is a mid-range aircraft with a composite wing, as well as promising Mi-38 and Ka-62 helicopters. The series production of the Russian-Ukrainian An-148 aircraft was launched in various modifications", - said the head of the government.

According to him, the consolidation of the aeronautical industry has been completed all enterprises and facilities that are part of the integrated structures have clear development prospects (The highlight of the second day of MAKS-2011 which was attended by Vladimir Putin, the oldest Russian fighter aircraft of the fifth-generation T-50 PAK FA).

It is assumed that the helicopters that the airline will receive under the contract will be engaged in meeting the needs of the oil and gas industry, performing flights related to installation and firefighting works, and will also be operated under the contracts. with the UN and abroad.

Dmitry Petrov, head of Russian Helicopters, noted that the airline is "the largest civilian customer of helicopter technology." There are now more than 50 Mi-171s in the UTair fleet.

In addition, the Russian helicopter holding and Gazpromavia signed on Wednesday on the air show MAKS-2011 in the presence of Russian Prime Minister Vladimir Putin a general agreement on the supply of 39 Mi-8AMT helicopters.

UTair Aviation also pleased Sukhoi Civil Aircraft with a contract to supply 24 Sukhoi SuperJet-100 aircraft under a leasing system. The total value of the transaction is 760.8 million USD in catalog prices, Interfax reports.

At the MAKS-2011 air show, Sukhoi Civil Aircraft also entered into an agreement with Gazpromkomplektatsiya for the supply of 10 Sukhoi SuperJet-100 / 95LR aircraft to Gazpromavia. The transaction is valued at \$ 323 million at current catalog prices. The delivery of the linings is scheduled for the period 2013-2015.

During the MAKS-2011 air show, the Ukrainian state-owned enterprise Antonov received a certificate for the production of Russian-Ukrainian regional passenger aircraft of the new generation An-158.

34 Ukrainian companies, 169 Russian companies, and other companies from 13 countries were engaged in the development and construction of the An-158 aircraft.

An-158 is a modification of the An-148 short-haul passenger aircraft. Compared to its predecessor, it has increased the number of passenger seats (up to 99), extended the passenger cabin, increased the volume of luggage racks, and reduced fuel consumption and operating costs. The flight range with the maximum number of passengers is 2.5 thousand kilometers.

For more than a year (it took off on March 9, 2015) the trip around the world "has ended", you might think that the development of passenger aviation has stopped or even going in the opposite direction. Of course, Solar Impulse 2 is not the future of aviation, but modern aircraft are slower than the supersonic Concorde flew 30 years ago. The new aircraft models generally differ from the old ones only in terms of higher fuel consumption. Airbus will not even develop a new aircraft by 2020. However, things are not so hopeless. The most promising projects in the field of aeronautics are described below, demonstrating that the development of aviation continues (García, 2020; Rana, 2020; Garfo et al., 2020; Kumar & Sreenivasulu, 2019; Mishra & Sarawagi, 2020; Welabo & Tesfamariamr, 2020; Antonescu & Petrescu, 1985; 1989; Antonescu et al., 1985a; 1985b; 1986; 1987; 1988; 1994; 1997; 2000a; 2000b; 2001; Aversa et al., 2017a; 2017b; 2017c; 2017d; 2016a; 2016b; 2016c; 2016d; Ayiei, 2020; Brewer, 1991; Chilukuri et al., 2019; Cao et al., 2013; Dong et al., 2013; Saheed et al., 2019; Riman, 2019; Matthews & Sun Yi, 2019; Dwivedi et al., 2019 a-b; Eremia, 2020; Hanrahan, 2014; He et al., 2013; 2008; Hertel, 2017; Komakula, 2019; Langston, 2015, 2016; Lee, 2013; Lin et al., 2013; Liu et al., 2013; Padula & Perdereau, 2013; Perumaal & Jawahar,

2013; Petrescu, 2011, 2012; 2019 a-v; 2020 a-g; Petrescu & Petrescu, 2019 a-f; 1995 a-b; 1997 a-c; 2000 a-b; 2002 a-b; 2003; 2005 a-e; 2011 a-c; 2012 a-b; 2013 a-e; 2014 a-h; 2016 a-c; 2020; Petrescu et al., 2007; 2009; 2016; 2017a-ak; 2018a-w; 2020; Petrescu & Calauti, 2016a-b; Dekkata & Yi, 2019; Fahim et al., 2019; Hassouni et al. 2019; Riman, 2018; Nacy & Nayif, 2018; Kortam et al., 2018; Welch & Mondal, 2019; Eissa et al., 2019; Younes et al., 2019; Svensson et al., 2004; Rahman, 2018; Richmond, 2013; Kisabo et al., 2019a-b; Kisabo & Adebimpe, 2019; Kosambe, 2019a-d; Sharma & Kosambe, 2020; Oni & Jha, 2019; Chaudhary & Kumar, 2019; Babu et al., 2019; 2020; de Mota Siqueira et al., 2020; Tumino, 2020; Mishra, 2020a-b; Brischetto & Torre, 2020; Vladescu, 2020).

2. METHODS AND MATERIALS

Airbus is testing a small but completely electric Airbus-E-Fan. The last achievement of the plane is the flight over the English Channel (Figure 5). To date, this model cannot be used for long flights, not even by a single person.

The problem with electric planes that also carry passengers is that they do not have enough energy to keep the aircraft in the air with a large mass (high load), and even less will they be able to reach high speeds, and obviously no acceleration sufficient for important or emergency maneuvers, so the safety of traffic on such aircraft is called into question.



Figure 5: Airbus is testing a small but completely electric Airbus-E-Fan
Source: <https://zizuhotel.ru/ro/rabota-bloggerom/innovacionnye-razrabotki-v-sfere-aviastroeniya-innovacionnaya/>

But many aircraft manufacturers have no doubt that the future belongs to electric aviation, or at least they want it, being an important goal, even an international directive. For

a start, it is planned, as in cars, to make a hybrid engine. Airbus intends to test a "more electric aircraft" as part of the DISPERSAL project in 2022. The contribution of the electric fan motor to the total force should be 23%.

NASA in 2016 announced the beginning of the development of the X-57 Maxwell aircraft equipped with 14 electric motors. It will be a small four-seater plane (Figure 6).



Figure 6: NASA in 2016 announced the beginning of the development of the X-57 Maxwell aircraft equipped with 14 electric motors

Source: <https://zizuhotel.ru/ro/rabota-bloggerom/innovacionnye-razrabotki-v-sfere-aviastroeniya-innovacionnaya/>

According to engineers, the introduction of electric motors will significantly reduce operating costs. The agency does not report when the aircraft will be created.

German startup Lilium Aviation has received funding to build a private electric jet capable of taking off and landing without an airport. For takeoff and landing, the plane will need only 225 meters. The company has already built a prototype and intends to unveil a full-size version at the end of 2018. The Boeing 737 MAX has already received 2,500 orders and could become a market leader (Figure 7).



Figure 7: The Boeing 737 MAX

Source: https://upload.wikimedia.org/wikipedia/commons/4/40/WS_YYC_737_MAX_1.jpg

The declared superiority over the existing Airbus A320neo leader is that it uses 4% less fuel. The first deliveries to customers will begin in 2017. Too bad that this super company has recently had image failures due to technical problems repeatedly reported on at least one basic model. The Boeing 737 MAX approached the time when it would resume commercial flights on Tuesday, with the help of the United States Aviation Administration (FAA), which said it would soon accept a proposal to re-authorize the aircraft, according to AFP.

The aircraft completed a series of certification flights in early July, a crucial step in its return to service, as civil aviation authorities cannot approve the modified version of the aircraft until they have examined its behavior in the air.

The Agency now intends to publish an "airworthiness" notice " in the near future".

"In line with our commitment to remain transparent, we will allow the public for 45 days to comment on the proposed changes to alleviate the safety issues identified in the investigations following the Lion Air and Ethiopian Airlines accidents", the FAA added.

The 737 MAX was banned from a flight on March 13, 2019, after the crash of an Ethiopian Airlines model that killed 157 people. The tragedy came just a few months after the disaster aboard a Lion Air MAX, which killed 189 people.

The FAA, whether or not it needs to give the green light to return to 737 MAX service, ensures "continuing a robust certification process." In January, Boeing did not receive any new orders for aircraft, being the first time such a thing had happened in January 1962 and until now, given that the once best-selling aircraft, the 737 MAX, remains listed at the ground after two serious accidents, Reuters reports.

As of March 2019, Boeing 737 MAX aircraft, the best-selling model of the American manufacturer, have been banned from flying worldwide after two air disasters that occurred within five months and in which a malfunction of the aircraft was suspected. The automatic flight stabilization system (MCAS) intended to prevent the airplane from entering the dive. The US aviation group hopes its aircraft will return to service by the end of 2019, following changes to software systems and pilot training programs, but in early December 2019, the Federal Aviation Administration (FAA) announced that it would not approve the resumption of 737 MAX aircraft flights before 2020.

The crisis caused by the 737 MAX forced Boeing to stop the production of its best-selling aircraft and change its general manager at the end of December.

Boeing's new long-haul aircraft, 777X, makes its first test flight on Saturday, taking off from Paine Airfield, near Everett, in the northeastern United States, reports AFP (Figure 8).



Figure 8: The Boeing 777X

Source: <https://www.boeing.com/commercial/777x/>

According to Boeing officials, this inaugural flight will last 3-5 hours and marks the start of a whole series of flight tests leading to the certification of the aircraft, before it enters service in 2021. The 777X, which can carry between 384 and 426 passengers, already has orders for 340 units, mainly from seven major airlines, including Emirates, Lufthansa, Cathay Pacific, Singapore Airlines, and Qatar Airways. The machine encountered significant problems during its September pressurization tests.

The 8-passenger Bombardier Global 8000 business jet will be able to fly a record 14,600 kilometers without refueling at an average speed of 956 km / h (Figure 9).

The company wants to start sales in 2019 at a price of about 65 million dollars. Gulfstream G600, new business aircraft that will be put on sale in 2018-2020, will also compete with the aircraft. The planes will cost from \$ 35 million to \$ 55 million.

The new private jet, the Cobalt Co50 Valkyrie (Figure 10), is cheaper than the competition (\$ 600,000) and is the fastest in its class, but its main design innovation is that it looks exactly like Bruce Wayne's plane. It can carry up to 5 passengers at a time.



Figure 9: Bombardier Global 8000

Source: <https://businessaircraft.bombardier.com/en/aircraft/global-8000#!#bba-pdp-section-4>



Figure 10 The new private jet, the Cobalt Co50 Valkyrie

Source:

https://en.wikipedia.org/wiki/Cobalt_Co50_Valkyrie#/media/File:Cobalt_Co50_Valkyrie_incomplete_prototype.jpg

The private SkiGull amphibious aircraft (Figure 11) will be able to land not only on water but in general on any surface (grass, snow, ice). It made its first flight in November 2015 and will be on sale soon.



Figure 11: The private SkiGull amphibious aircraft

Source: https://upload.wikimedia.org/wikipedia/commons/c/c6/SkiGull_in_flight_%28skis_deployed%29.jpeg

The SkiGull is a two-seater composite/titanium aircraft equipped with a retractable ski train that can have wheels attached for operations on water, snow, or land, landing on an area of about 400 meters, but with a range to cross oceans. The engine is configured to run on Swift fuel, for car or boat. The aircraft is privately developed.

The public presentation of the SkiGull design was made at the EAA Airventure Convention in 2015. Details include the ability to operate in ocean waves with skis or land on smooth water or grass with retracted skis, cruising speed of 140 knots (optional turbocharger 177 knots), quiet flight, 460-foot water take-off, 47-foot longwing (foldable), trailer-free ground transportation, a 44% long Fowler flap behind the main propeller and two foldable front-facing electric motors reversible propellers simplify docking and provide optional take-off power.

Another seaplane, the two-seater Icon A5, is capable of taking off and landing on water and can also come out of a spin and is equipped with a parachute for the entire aircraft (Figure 12).

It is recognized as so safe that you do not even need a pilot's license to obtain a flight permit, 20 hours of training are enough. It costs \$ 250,000 and is already in production. In 2016, the first 7 pieces were assembled, but 1,850 orders had already been placed for the plane.



Figure 12: The two-seater Icon A5

Source: https://es.wikipedia.org/wiki/ICON_A5#/media/Archivo:Icon_A5_in_the_water.jpg

The Cirrus Vision SF50 business aircraft is without a doubt the first mass-produced personal aircraft (Figure 13). It will be able to carry up to 7 passengers and should be much easier to fly than a regular private jet.

It will also have a parachute for the entire plane. 4 prototypes were built, and the first aircraft was delivered to the customer in June 2016. In total, over 600 of these cars have already been ordered at a price of 2 million dollars.



Figure 13: The Cirrus Vision SF50 business aircraft
Source: <https://www.cirrusaircraft.com/aircraft/vision-jet/>

The single-seater British e-Go jet is unique for its low price of only \$ 70,000, cheaper than many cars (Figure 14).



Figure 14: The single-seater British e-Go jet is unique for its low price of only \$ 70,000, cheaper than many cars

Source: <https://www.avweb.com/news/first-flight-for-british-single-seater/>

The first buyer received the plane in June 2016. A British company has designed and flown a new airplane, the e-Go, powered by a Rotron Wankel rotary engine. The design fits into the Single Seat De-Regulated class, established by the UK in 2007, which is similar to the U.S. ultralight class. The e-Go flew for the first time last week completing several test flights and a demo flight for supporters and the press. With a top speed of 135 knots, the airplane is too fast to qualify as an ultralight in the U.S., but the developers are taking deposits for copies in the UK. It sells for about \$80,000. They also plan to develop an experimental kit version and an LSA for the U.S. market. "We set out to design a fun flying machine," company founder Tony Bishop told the BBC. "It's lighter and faster and more fun to fly, we think than anything that's out there."

Officially, the Italian company AgustaWestland with the AW609 tiltrotor came closest to the creation of the VTOL transport (Figure 15). It is indeed capable of landing vertically and flying farther than conventional helicopters, but its speed (509 km / h) is still significantly lower than aircraft. Until now, the tiltrotor has been produced only for the needs of the US military. But the AW609 will be civilian transportation for businessmen and the oil industry. Certification is expected in 2017 and 70 orders have already been received.

BA609 was based on the experience gained by Bell's previous experimental tiltrotor, XV-15. In 1996, Bell and Boeing formed a partnership to develop a civilian landing plane; however, in March 1998, it was announced that Boeing had abandoned the project. In September 1998, it was announced that Agusta had become a partner in the development program.

This led to the establishment of Bell / Agusta Aerospace (BAAC), a joint venture between Bell Helicopter and AgustaWestland, to develop and manufacture the aircraft. The Italian Government has subsidized the development by Agusta of a military tiltrotor and, given that the AW609 has civil problems, the European Commission is asking AgustaWestland to reimburse the progressive sums per aircraft to the Italian state in order to avoid distortions of competition. Since 2015, Bell has continued to perform contract work on the AW609 program, given the commercial potential for a larger V-280 tiltrotor, where military production can reach a higher number and therefore reduce the unit cost.

The purpose of the plane is to take off and land vertically, but to fly faster than a helicopter. More than 45 different aircraft flew proving the capabilities of VTOL and STOL, of which V-22, Harrier "jump jump", Yakovlev Yak-38 and Lockheed Martin F-35 Lightning

It went into production. Until 2008, Bell estimated that very light aircraft and large offshore helicopters, such as the Sikorsky S-92, reduced the potential rotor market. Also in 2008, limited funding for the program by Bell and AgustaWestland was reported to have led to slow progress in flight testing.

On September 21, 2009, Agusta Westland CEO Giuseppe Orsi said that parent company Finmeccanica authorized Bell Helicopter to buy the program to speed it up because Bell was unhappy with the business outlook and wanted to spend resources on other programs. In 2013, AgustaWestland estimated a market of 700 aircraft over 20 years. Until 2011, negotiations focused on the full transfer of shared technologies with the V-22, however, Bell said no technology was shared with the V-22.

At the 2011 Paris Air Show, AgustaWestland said it would take full ownership of the program, redesignating the aircraft as the "AW609" and that the Bell helicopter would remain in the role of component design and certification. In November 2011, the exchange of ownership was completed, following regulatory approval - the media estimated that the transfer took place at a low cost.



Figure 15: The AW609 tiltrotor came closest to the creation of the VTOL transport
Source: https://upload.wikimedia.org/wikipedia/commons/0/0a/BA609_02.jpg

The first ground tests of the BA609 prototype began on December 6, 2002, and the first flight took place on March 6, 2003, in Arlington, Texas, piloted by test pilots Roy Hopkins and Dwayne Williams. After 14 hours of testing the helicopter flight, the prototype was moved to a ground test platform to study the operational effects of the conversion modes.

After the completion of the ground tests on June 3, 2005, the prototype resumed the flight tests, focusing on the expansion of its flight tire.

On July 22, 2005, the first conversion from a helicopter to airplane mode took place during the flight. Since October 2008, two prototype hours have recorded 365 flight hours. The AW609 demonstrated safe double engine failure in normal cruising flight on 15 May 2009. By February 2012, it had increased to 650 hours and it was reported that 85% of the AW609's flight tire had been explored. Test pilot Paul Edwards said the AW609 was not susceptible to vortex ring state phenomena, naturally slipping only from the vortex, as both rotors will not simultaneously enter the vortex ring state.

In 2011, AgustaWestland began construction of a third prototype; that prototype was not yet fully assembled by February 2015. The company plans to conduct test flights in Italy in the summer of 2015. AgustaWestland then planned to disassemble it and send it to Philadelphia, Pennsylvania, to prepare it for testing thaw from Minnesota.

A fourth prototype, which will be used for the development and testing of new control and avionics systems, was also underway. By November 2012, the two operational prototypes had accumulated over 700 flight hours. In January 2014, it was reported that the two prototypes had accumulated over 850 flight hours; the accumulated flight data are used to further develop representative simulators, which in turn are used to support the development program.

The AW609 is a tiltrotor aircraft capable of landing vertically, while conventional fixed-wing aircraft cannot, allowing the type to serve locations such as heliports or very small airports while having the speed and range of any helicopter available. AgustaWestland promotes the type as "... combining the benefits of a helicopter and a fixed-wing aircraft into a single aircraft".

The AW609 appears to be similar in the exterior to the Army-oriented V-22 Osprey; however, the two aircraft have several components. Unlike the V-22, the AW609 has a pressurized cabin. Since 2013, several cabin configurations have been designed, including a standard nine-passenger structure, a six- to seven-passenger VIP / executive cabin and a hoist/basket search and rescue model, and four single seats; medevac-oriented and patrol/surveillance variants have also been proposed. For increased passenger comfort, the cabin is both pressurized and equipped with sound insulation. Access to the cabin is through a

two-piece door in the building, 35 inches (89 cm) wide, fixed centrally in the fuselage under the wings (Figure 16).



Figure 16: The AW609

Source: https://upload.wikimedia.org/wikipedia/commons/9/9e/Bell_augusta_convertiplano.jpg

DARPA announced a competition to finally create a vertical take-off aircraft (Figure 17) and 4 large corporations (Boeing, Aurora Flight Sciences Corp, Sikorsky Aircraft Co, and Karem Aircraft) presented their full-size prototypes for testing in February 2017.



Figure 17: The Sikorsky moves forward with DARPA VTOL X-Plane project to design new military tiltrotor aircraft

Source: <https://www.militaryaerospace.com/unmanned/article/16718602/darpa-competitors-vying-to-design-fast-verticaltakeoff-aircraft-expands-to-four>

Northrop Grumman upgrade E-2D flight computers to accommodate teaming among manned and unmanned aircraft. MUM-T involves standard computer architecture and communications protocol to share live and still, images gathered from UAV sensor payloads (Figure 18).



Figure 18: Northrop Grumman upgrade E-2D flight computers to accommodate teaming among manned and unmanned aircraft

Source: <https://www.militaryaerospace.com/computers/article/14187192/teaming-e2d-unmanned>

Companies building sixth-generation Tempest fighter jets in the UK have unveiled some of the technological concepts they will incorporate, including a radar system designed to handle as much data per second as a city. Developing for the Royal Air Force (RAF), Tempest will be one of the first fighters of the sixth generation. It is designed to complement current combat craft, such as the F-35 Lightning II and Typhoon fighters, from the mid-2030s until older warplanes are withdrawn in the 2040s. The stealth fighter will be able to carry hypersonic missiles and control drone swarms as well as produce large amounts of electricity, allowing it to power laser weapons.

Along with this, the Delta Tempest twin-engine wing will have reconfigurable artificial intelligence and cybernetically enhanced communications, which allow it to act as a flying command and control center, where the pilot acts more as an executive officer than as a dogfighter (Figure 19).



Figure 19: Tempest sixth-generation jet fighter will have high-speed radar, artificial intelligence (AI)

Source: <https://www.militaryaerospace.com/sensors/article/14187088/radar-jet-fighter-artificial-intelligence>

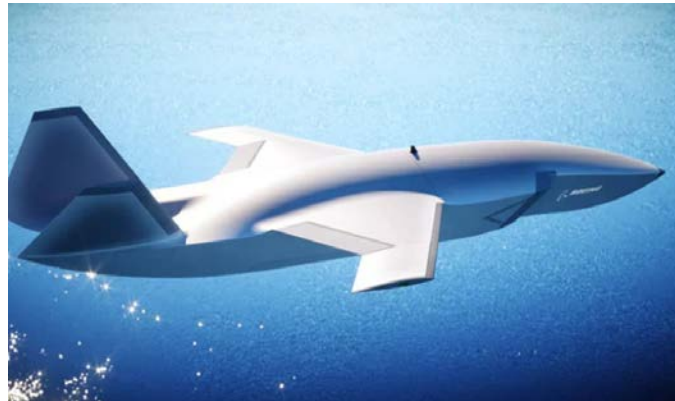


Figure 20: Physical to develop artificial intelligence (AI) algorithms for high-performance unmanned combat aircraft

Source: <https://www.militaryaerospace.com/computers/article/14185259/artificial-intelligence-ai-unmanned-combat-aircraft>

U.S. military researchers are asking artificial intelligence (AI) experts at PhysicsAI in Pacifica, Calif., to develop AI algorithms to enable future experimental high-performance unmanned combat aircraft to formulate teams of manned and unmanned jet fighters (Figure 19-20).

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced a \$2.3 million contract to PhysicsAI earlier this month for the Air Combat Evolution (ACE) Technical Area 1: Build Combat Autonomy project.

This project seeks to increase warfighter trust in combat autonomy by automating aerial within-visual-range maneuvering using realistic aircraft.

Airbus wants to become carbon neutral by 2035.

Thus, a design is designed to carry up to two hundred passengers with a range of two thousand nautical miles.

The project includes a hydrogen turbofan, which is rotated by a modified gas turbine engine. Liquid hydrogen would be stored and distributed in tanks at the rear of the aircraft (Figure 21).

The second design, which can carry up to a hundred passengers, uses a turboprop engine, which also runs on hydrogen. It is intended for short-distance travel, covering about a thousand nautical miles. Finally, a third model, the largest of the three, is designed to accommodate two hundred passengers. The concept combines the wings with the main body, creating a massive open space. "The extremely wide fuselage opens up multiple options for hydrogen storage and distribution and for cabin layout," an Airbus statement said.

Airbus hopes to spark enthusiasm with these launches around the idea of powering tomorrow's aircraft using hydrogen gas. "The transition to hydrogen, as the primary source of energy for these concept aircraft, will require decisive action from the entire air ecosystem," said Guillaume Faury, CEO of Airbus.

"I strongly believe that the use of hydrogen - both in synthetic fuels and as a primary source of energy for commercial aircraft - has the potential to significantly reduce the impact of the aviation climate," he added. There is still a lot to be done for this to become a reality. For example, airports should invest significantly in a facility needed to transport and supply hydrogen - if the idea is to mature beyond the conceptual stage.

Sooner or later, hydrogen will become the number one fuel for aviation and aerospace, whether it is burned or used as a raw material to obtain nuclear fusion energy directly on the spacecraft. Hydrogen is practically the future source of energy and the key to successfully solving the energy problem in aerospace and aviation but also in other industrial and civil fields.



Figure 21: The project includes a hydrogen turboprop, which is rotated by a modified gas turbine engine

Source: <https://playtech.ro/2020/airbus-dezvaluie-trei-modele-de-avioane-alimentate-cu-hidrogen/>

This Wild New Aircraft Could Make Private Aviation as Affordable as Flying Commercial (Figure 22).



Figure 22: The laminar-flow design of the Celera 500L gives it a 4,500-mile range while its operating costs are about a sixth of competitive business jets

Source: <https://robbreport.com/motors/aviation/new-aircraft-revolutionize-private-aviation-2947829/>

The laminar-flow design of the Celera 500L gives it a 4,500-mile range while its operating costs are about a sixth of competitive business jets.

The new Celera 500L, which recently completed more than 30 test flights, plans to go wing to wing with business aircraft of the same size. But this clean-sheet design, which can pair most cities in the continental US, will have 80% fewer emissions than most business planes of the same size, about a sixth of the operating costs, according to its designer.

Californian operator Otto Aviation intends to rewrite private aviation, making it as accessible as commercial air travel. "Individuals and families will be able to rent the Celera 500L at prices comparable to commercial rates, but with the added convenience of private aviation," said William S. Otto, Sr., president and chief scientist of the company, in announcing the aircraft.

The initial statistics are impressive. Celera's top cruising speed exceeds 460 mph - similar to most light aircraft - while its fuel economy of 18-25 miles per gallon makes it fuel-efficient compared to similarly-sized jet aircraft, which reach only 2 mpg. Operating costs of \$ 328 per hour are also significantly lower than the \$ 2,100 per hour for the conventional business jet. At 4,500 nautical miles, the Celera also has the transcontinental range of a large aircraft.

Flat wings are traditionally strong, thick, and robust, but a NASA-led team of researchers has created a flexible wing that transforms as it flies. With a width of 14 meters or four meters, the new wing is built of thousands of units that fit together and work similarly

to a bird's wing, says one of the report's authors, NASA research engineer Nick Cramer. "Something like a condor will lock its joints during the cruise, then (adjust) its wing in a more optimal shape for the cruise and when it wants to make a more aggressive maneuver, it will unlock its shoulder. Here, "he said in a telephone interview (Figure 23).

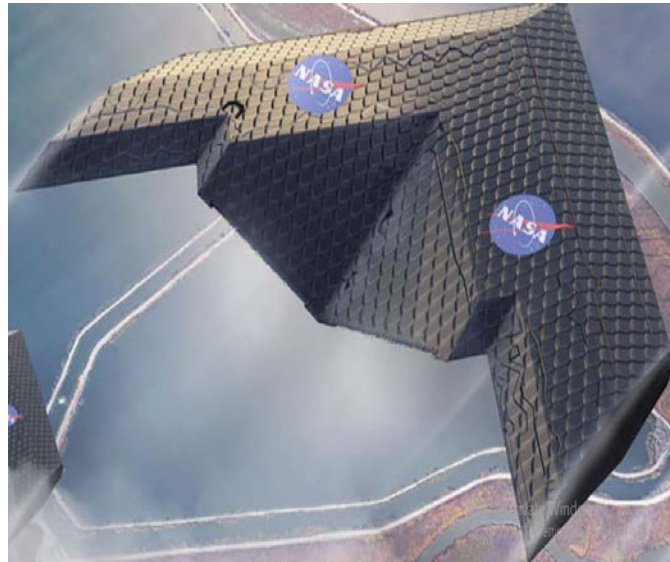


Figure 23: The new plane wing moves like a bird's and could radically change aircraft design
Source: <https://edition.cnn.com/style/article/nasa-mit-airplane-wing/index.html>

But it's not just how the new wing works that differentiate it, according to researchers who co-authored a paper published this week in the journal *Smart Materials and Structures*.

The main areas of the airline's innovative activities:

- Development and production of a new transport product;
- Improving the commercial characteristics of transport on developed routes;
- Mastering new and improving existing work technology in all functional areas of activity;
- Development of innovative potential.

Most aviation enthusiasts associate supersonic flights with Concorde, but its last commercial flight took place in October 2003. There was also a Tupolev Tu-144, but it was in circulation until June 1978. Subsequently, supersonic aircraft was abolished due to the massive noise, the exaggerated degree of polluting emissions, the incredible consumption, and, last but not least, the price of a trip.

Now, they are trying to bring the supersonics back to the present, by partially remedying the problems that led to their elimination. This category also includes Boom Supersonic, which has been in research and development for about 6 years. Before unveiling a generously sized creation for passengers, Boom just announced the XB-1 (Figure 24).

Boom XB-1 was created as a concept aircraft, for testing technologies that will be integrated into a significantly larger edition for passengers. Test flights with the little XB-1 will start in 2021 (Figure 24).



Figure 24: Test flights with the little XB-1 will start in 2021

Source: <https://static.playtech.ro/wp-content/uploads/2020/11/avion-persoane-supersonic.jpg>

If all goes well, Boom could create the first completely new supersonic plane of people in about half a century. The first public details about this project began circulating on the Internet in August this year.

Boom XB-1 or Baby Boom has a length of 21.6 meters and is built around a composite carbon fiber frame. Propulsion is provided by 3 General Electric J85-15 engines, designed to provide 12,000 pounds of thrust. It is important to note that the J85 is a long-range engine on the market since the 1950s, but it seems to have been optimized to minimize the polluting impact on the environment.

To materialize this concept, Boom collaborated with Stratays and Velo 3D to reduce production costs by 3D printing of several parts. In the future, the company's creators hope to create the first supersonic Overture for passengers in 2025, with the first commercial flight taking place in 2029.

Electric aircraft manufacturer Pipistrel is advancing plans for a pair of new cargo aircraft and a 19-seat regional aircraft. In the May 13 newsletter from its US distributor, the

Slovenian company indicated that it intends to focus on these new developments more urgently than on its plans for the Pipistrel 801 eVTOL, which was selected by the Uber rideshare group for the planned Uber air, urban product of air mobility (Figure 25).

"The changes to the company's priorities came after delays with the Uber flight taxi program by many international aviation authorities," the company said: "The continued extension of the deadline for the development of a flying taxi service, which was commissioned by the American company Uber, has given Pipistrel time to investigate future opportunities, some of which have been in the planning and development for several years".

Uber Air services are to be launched in 2023 in one or more early adopted cities that the company has identified, including Dallas, Los Angeles, and Melbourne, Australia. "We continue to see progress against our vision for Uber Air among many of our vehicle partners, despite the challenges that come with Covid-19," Uber Air told AIN. "We expect some partners to proceed faster than others, but we remain focused on preparing for Uber Air's commercial service on our own terms".

Pipistrel is one of the eight "vehicle partners" selected by Uber, the others being the subsidiary of Boeing Aurora Flight Sciences, Bell, Embraer X, Hyundai, Jaunt Air Mobility, Joby Aviation, and Karem Aircraft. The company insisted that it remains fully engaged as Uber's Elevate project, which is preparing for the launch of Uber Air. A Pipistrel spokesman told AIN that it had decided to "reduce the intensity" of the development on the grounds that "due to regulatory and other constraints" it would not be realistic to access the 801 eVTOL service by 2028.

"The 801 project was never interrupted, but continues at a slow pace, in favor of accelerating the delivery of large cargo UAVs," the company explained. "We keep both projects in parallel, allowing the use of the same development methodology and tools for both vehicles." The project flew several scale models and performed large-scale system tests in the meantime".

One of the cargo planes now advanced by Pipistrel has a design similar to the 801 eVTOL and would carry a payload of 660 pounds, about 200 miles. The company said it plans to deliver the first aircraft to an undisclosed Asian customer in 2022, but has not yet released further details about its performance and specifications. The second cargo plane is a fixed-wing design based on Alpha Pipistrel light electric aircraft. It is developed to be piloted

or remotely piloted and would be used for missions such as humanitarian aid, the packages being thrown from the pods on each side of the wing, and a payload of almost 250 pounds.



Figure 25: The Pipistrel 801 eVTOL

Source: <https://www.ainonline.com/aviation-news/business-aviation/2020-05-14/pipistrel-slows-uber-evtol-work-advance-other-new-aircraft>

Meanwhile, Pipistrel is working on the development of a 19-passenger aircraft that it says would fly routes of up to 300 miles at about a quarter of the operating cost of conventional aircraft. The company reported that the so-called Miniliner concept could be ready for launch in 2028. The company explained that the 19-seater aircraft is part of the Unifier 19 project, being developed in partnership with various undisclosed academic partners.

The paper leverages the efforts of a separate Mahepa project, led by Pipistrel, which develops and tests various new propulsion technologies, including electric fuel cell and hydrogen propulsion systems. The Pipistrel team hopes to start testing the flight of a prototype for this design before the end of 2020. Aerospace engineers at the Delft University of Technology in the Netherlands have come up with a new, highly innovative concept that aims to integrate the passenger compartment, cargo hold, and fuel tank into a V-wing model (Figure 26).



Figure 26: The Flying-V concept

Source: <https://www.thejakartapost.com/travel/2019/06/07/new-fuel-efficient-aircraft-design-squeezes-passenger-cabin-into-v-shaped-wings.html>

The result is a super sleek aircraft with an advanced futuristic look that manages to use 20% less fuel than the Airbus 350.

This new concept started as a dream imagined by Justus Benad, a student at the Delft University of Technology, in his thesis project at Airbus Hamburg, a concept that enhances the traditional bird-like design - very long fuselage with wings on both sides - and makes wings the main storage space of the Aircraft.

Such a design also offers a unique opportunity to rethink the passenger experience, a pleasant and unforgettable experience, said Peter Vink, professor of applied ergonomics and design.

"This new form of aircraft creates interesting opportunities for us to rediscover the interior of a modern passenger aircraft, leading to a much more comfortable flight for them. As an example, an integral part of Flying-V research, we are looking for new options for

passengers. to be able to rest or eat in an airplane. An airplane should no longer be a way of stress but on the contrary."

The aircraft is powered by turbofan engines located above node V. At 65 meters, the wing opening has been designed to be the same as the A350, allowing it to be used on existing infrastructure such as airports, gates, runways, and hangars without difficulty. Like a smaller version of the A350, the Flying-V has a smaller inlet area, resulting in lower forward resistance, leading to a dramatic drop in concept aircraft fuel consumption. It will also require much less fuel for long-distance travel, given that today global aviation is responsible for 2.5% of total carbon emissions, a figure that will increase as air travel continues to increase and they.

Last autumn, the Dutch aviation sector proposed a plan to reduce CO2 emissions by 35% by the end of 2030. A flying prototype will be unveiled at Amsterdam Schiphol Airport in October, as part of KLM's 100th anniversary.

In the video from which I extracted figures 26-30, in addition to the V-plane, other new future concepts are presented that want to change the way they fly radically, so that passengers feel comfortable, like at home, sitting in comfortable and pleasant armchairs and practicing what they would have done at home (to work on a laptop, to watch a movie on it, to relax in any other way, while they will fly over very long distances fast and safe but especially comfortable).

The V-shaped model has already been shown in Figure 26, in figure 27 being briefly presented another Airbus prototype having a V with a slightly smaller aperture than the previously presented model and the wings compactly connected together and with the central body of the new aircraft concept.

The aerodynamics of the concept Maveric in the Figure 27 is fantastic. The interior of the aircraft is designed to offer special comfort to the passengers, having the possibility to impose on them some sensations of peace and calm, of real relaxation



Figure 27: The new Airbus Flying compact concept Maveric
Source: https://www.youtube.com/watch?v=_npxdn5LP0&feature=emb_rel_end

Lilium will be a new fully electric air taxi that will have increased autonomy and a relatively high speed compared to other similar models (Figure 28).

Daniel Wiegand, the Lilium designer, hopes that his new concept will become a very cheap future air taxi, allowing him to fly between two big cities for only \$ 70. It has been wanted for a long time to build civil air taxis, but this year more than ever new and new models have appeared in this sense so that in the future they can be tested and later successfully introduced into circulation, and the models will not it was too late to multiply and diversify further. They must be cheap in addition to the main features of flight safety and comfort. Daniel's model already has this great advantage of its use at low costs for the manufacturer, user, and passengers.

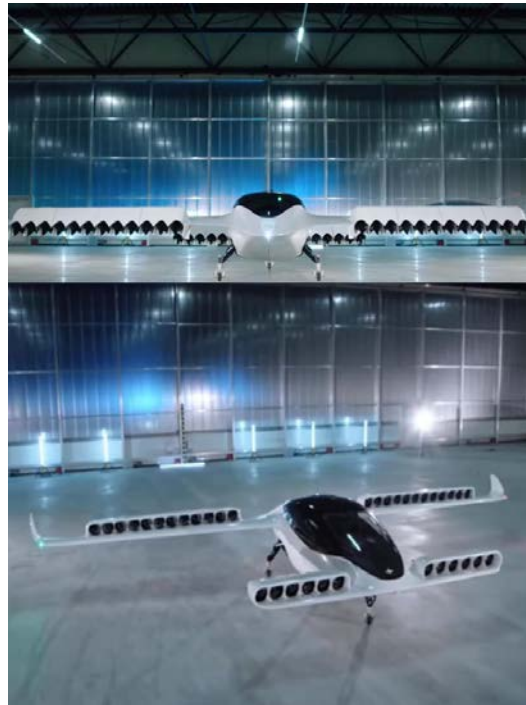


Figure 28: The Lilium electric air taxi

Source: https://www.youtube.com/watch?v=_npxdrn5LP0&feature=emb_rel_end

Virgin Galactic is working with Richard Branson on Baby Boom, a new supersonic project that will fly from New York to London in just three hours, being a worthy successor to the Concorde due to its average supersonic speed of 2335 km / h (Figure 29).



Figure 29: The supersonic Baby Boom

Source: https://www.youtube.com/watch?v=_npxdrn5LP0&feature=emb_rel_end

Progress Eagle (Figure 30) will have 0 (zero) emissions and will carry over 800 passengers at very high speeds and in super pleasant comfort.



Figure 30: The Progress Eagle

Source: https://www.youtube.com/watch?v=_npxdrn5LP0&feature=emb_rel_end

The US says it has tested a top-secret sixth-gen fighter. The aircraft was created using digital engineering, which allows the service to bypass the regular manufacturing process (Figure 31).



Figure 31: The US top-secret sixth-gen fighter. It has Laser shooting weapons.

Source: <https://asiatimes.com/2020/09/us-says-it-has-tested-a-top-secret-sixth-gen-fighter/>

The US top-secret sixth-gen fighter has Laser shooting weapons.

Samad Aerospace tells us that it has managed to develop a new two-seater VTOL concept, the Q-Starling, which was inspired by various places and modes from the Mustang P51 to the Hawk fighter to the Maserati, but there is something nautical in width and in its shape reminiscent of the beak of ducks while its rear is narrowed aerodynamically as in turbo or supersonic aircraft. Its unique appearance inspires a sense of innovation that extends even to the function and mission of Q-Starling.

The company declares it to be a "jet aircraft", one of the few VTOLs in the Personal Aviation Vehicle (PAV) category, the Q-Starling being not a helicopter or drone design, but rather two-seater wings, or perhaps better said a combination. The company believes that the design will be an advantage in the early stages of VTOL adoption, as the design of the aircraft is more in line with existing regulations on air traffic and landing infrastructure. Eventually, it will function as a VTOL aircraft.

For take-off and landing, the large doors at the bottom open to expose a large moving fan powered by a hybrid diesel-electric turbo-generator and a battery bank. Stability and maneuverability are ensured by the lower wing tips and rear fans. Once the doors are closed, the large fan creates enough forward traction to generate a projected cruising speed of 300 mph with a range of 500 miles (Figure 32).



Figure 32: The Samad Aerospace tells us that it has managed to develop a new two-seater VTOL concept, the Q-Starling

Source: <https://robbreport.com/motors/aviation/samad-q-starling-vtol-aircraft-1234571738/>

It cannot be said that there are shortcuts to aviation safety - it is up to engineers to manage budgets and safety risk programs, even when testing new types of aircraft, such as eVTOL.

Air consultancy Roland Berger counted 170 electric planes developing worldwide for a study published in July last year, but it is estimated that the number will increase to almost 200.

By far, the largest number of these aircraft are electric vertical take-off and landing aircraft (eVTOL) - clean sheet metal projects using electric propulsion trains and propulsion systems in completely new ways. Development programs are taking place mainly in the US and Europe, where many start-ups are beginning to face the reality of transforming CAD drawings into metal and composite materials moving in the sky.

Bristol-based Vertical Aerospace, based in the UK, hopes to be one of the first companies on the market with an eVTOL aircraft. The company intends to complete the testing and certification of its first aircraft by 2023 and start services on short-haul flights. During operation, Vertical intends to extend the range of the aircraft and, finally, to introduce its range, while extending the number of routes it can serve. The company, which was founded in 2016, flew the first demonstration of the concept at Cotswold Airport in the UK in June 2018.

Vertical engineers recently completed the flight test of the second large prototype, called Seraph, which weighs 1000 kg, it can reach speeds of up to 80 km / h and carry loads of up to 250 kg. Seraph, which underwent ground tests a few months ago, takes design clues from multi-rotor drones and, like many eVTOL aircraft, can be described as an enlarged drone.

Seraph has completed its first flight testing campaign without major incidents, thanks in large part to Paul Harper, the chief certification engineer at Vertical Aerospace. Harper is responsible for ensuring the safety of Seraph flight tests and liaising with the UK Civil Aviation Authority (CAA). He said: “We started as a small group of people in charge of taking over the drone technology and expanding it into a useful aircraft.

A new presentation of a new development concept of the old B 21 Raider launched by the US Air Force (USAF) of the top-secret Northrop Grumman B-21 Raider presents seemingly subtle but obvious differences compared to its predecessor stealth bomber, Northrop Grumman B-2A Spirit.

It describes the bomber parked in hangars at several US air bases, which is expected to host the flying wing in the future, including Dyes Air Force Base (AFB) near Abilene,

Texas; Ellsworth AFB, near Rapid City, South Dakota; and, Whiteman AFB near Kansas City, Missouri (Figure 34).



Figure 33: The Vertical Aerospace's latest prototype, Seraph, can fly at speeds of up to 80km/h and carry 250kg, the equivalent of three passengers

Source: <https://www.aerospacetestinginternational.com/features/safety-in-aviation.html>



Figure 34: A new presentation of a new development concept of the old B 21 Raider launched by the US Air Force (USAF)

Source: [https://en.wikipedia.org/wiki/Northrop_Grumman_B-](https://en.wikipedia.org/wiki/Northrop_Grumman_B-21_Raider#/media/File:Artist_Rendering_B21_Bomber_Air_Force_Official.jpg)

[21_Raider#/media/File:Artist_Rendering_B21_Bomber_Air_Force_Official.jpg](https://en.wikipedia.org/wiki/Northrop_Grumman_B-21_Raider#/media/File:Artist_Rendering_B21_Bomber_Air_Force_Official.jpg)



Figure 35: APUS i-5 Rolling-Royce Hybrid Electric Demonstration Aircraft

Source: <https://billionairetoys.com/rolls-royce-hybrid-powered-apus-i-5-demonstrator-aircraft/>

Rolls-Royce earlier created an M250 hybrid power system and performed ground tests. The APUS i-5 aircraft will now be used to demonstrate its integration with an aircraft.

The M250 hybrid package also complements systems developed for larger aircraft, as seen with the E-Fan X demonstrator

Earlier this year, Rolls-Royce announced that it was conducting ground tests of a hybrid-electric propulsion system built around a turbo engine with an M250 shaft. All he needed now was to find an airframe in which to integrate the system. Rolls-Royce has now discovered that aircraft and taken another significant step toward achieving its ambition to provide hybrid-electric propulsion systems for the next generation of aviation (Figure 35).

A futuristic Flying Vehicle like in Star Wars is projected in secret for the US army (Figure 36).

The flying bicycle can transport 2 people at 70 km / h, being a very small but powerful vehicle with enough autonomy to transport a passenger from one place to another, for rescue missions and quick evacuation (Figure 37).



Figure 36: A futuristic Flying Vehicle like in Star Wars is projected in secret for the US army
Source: <https://www.youtube.com/watch?v=YU3EqoUXsvY>



Figure 37: The flying bike
Source: <https://www.youtube.com/watch?v=YU3EqoUXsvY>

The flying mansion (Figure 38) is designed in such a way as to become a flying house, or rather a flying palace, being equipped with lounges, bathrooms, kitchen, living room and luxurious bedrooms, swimming pool, and practically everything comfort desired by anyone, being one of the largest flying vehicles currently available, with great comfort, extraordinary safety, easy maintenance in the air, low fuel consumption, it can be designed with zero emissions, only with electric motors.



Figure 38: The flying Mansion

Source: <https://www.youtube.com/watch?v=YU3EqoUXsvY>

Obviously maintaining at a certain altitude without fuel consumption, in great safety, is done with the balloon, the aircraft being in fact a modern airship, which has the additional possibility to move at high speeds, to stay in the air at any altitude safely without energy efforts.

A similar model is shown in Figure 39, which also has facilities for leisure in the air, long and very long journeys, pleasant, comfortable and safe, which will compete with those on water, sea, and oceans so far. Probably many retirees with financial possibilities will embark in the future on such an aircraft, replacing the classic pleasure tourist routes on transatlantic ships.



Figure 39: The most expensive Private Jets in the world

Source: <https://www.youtube.com/watch?v=ZejhDmW4A0Y>

Hexplane, or the hybrid with six helicopter-type passenger engines

V-22 Osprey is a very bold futuristic concept imagined and thanks to today's drones with 3, 4, 5, 6, or n helicopter engines (Figure 40).



Figure 40: Hexplane, a Six-Engine Airliner-Helicopter Hybrid

Source: <https://www.wired.com/2012/01/hexplane-oliver-vtol/>

Reaction Engines testing ammonia as carbon-free aviation fuel (Figure 41).

Reaction Engines and the UK Council for Science and Technology Facilities (STFC) have jointly launched an important study aimed at fuel diversification and have succeeded in finalizing a concept of how practical it is to introduce and use ammonia as a fuel for jet aviation. Reaction Engines heat exchanger technologies and STFC's advanced catalysts were used to create a new, reliable, low-emission propulsion system for the immediate future.

Today's modern jet engines already use a wide variety of kerosene-based fuels, all of which have a very high energy density, so that they can propel aircraft far beyond the speed of sound and transport passengers and goods around the globe extremely quickly and safely.

The downside of these current types of fuels is that they also come from fossil fuels and produce significant carbon dioxide emissions, which the airline industry and many governments have made a serious commitment to drastically reduce them until 2050.

One possibility to achieve these reductions is precisely the analysis and then the introduction of conventional jet fuels to supply aircraft with a low percentage of pollution during operation. But the major problem with all the alternatives already studied so far is that most of these alternatives have much lower energy densities than standard aviation fuels. On the other hand, for example, current battery technology would require that future aircraft be very small, with a short-range and an extremely low charging capacity.



Figure 41: Reaction Engines testing ammonia as carbon-free aviation fuel
Source: <https://newatlas.com/aircraft/reaction-engines-ammonia-carbon-free-aviation-fuel/>

For this reason, today when we talk about electric motors in aviation we either think of hybrid solutions that burn classic fuels and generate electricity that then power the electric motors or small planes with electric batteries that do not allow fast and long-distance flights or very large and the weight they can carry is also very low. In the meantime, liquid hydrogen could be a viable alternative, and today from today's perspective only hydrogen is the most powerful non-polluting fuel that can be massively deployed in aviation, with already permitted methods in place, but has not yet been mass introduced. It still requires many studies, major technological changes, other infrastructure, new devices for production, storage, and use, but it should be transported so much that the aircraft should be completely redesigned and a new aerospace infrastructure built.

The idea of using ammonia as aviation fuel is not entirely new. Although it has only a third of the energy density of diesel, ammonia is easier to liquefy and store, and in addition it has already been tested and used by the famous X-15 rocket aircraft, propelling it into space at a whole series of suborbital missions from the 1950s and 1960s. In addition, it does not

contain carbon and will not pollute the environment with all kinds of by-products of carbon and oxygen resulting from the burning of hydrocarbon fuels.

Its most difficult point is the achievement of an economically and financially viable way for its massive introduction into aviation. To this end, Reaction Engines produced a new propulsion system based on the heat exchanger technology it developed for its SABER hypersonic engine, which was then evaluated by STFC's Rutherford Appleton Laboratory near Didcot in Oxfordshire. In this new system, ammonia is practically stored as a pressure-cooled liquid in the wings of the aircraft, similar to kerosene-based fuel.

The heat obtained from the engine by the heat exchanger will heat the ammonia as it is pumped and fed into a chemical reactor where a catalyst breaks down some of the ammonia into hydrogen. The fuel actually used will therefore not only be ammonium but a higher ammonia/hydrogen mixture then sent to the jet engine, where it burns like a conventional fuel, although the emissions consist mainly of nitrogen and water vapor.

So the only major pollutants could be some combinations of nitrogen, much less harmful than those of carbon and oxygen. The solution at the end, therefore, uses not only ammonium but ammonium and hydrogen obtained on the ship itself (in this way it is no longer necessary to produce and store hydrogen in special devices).

According to Reaction Engines, the energy density of ammonia is not enough to create additional problems for engines and aircraft in the sense of the need for constructive and technological changes, but perhaps only some insignificant changes so that the engine can be upgraded in a relatively short time. A ground test is currently underway, with a first possible flight in a few years.

"The combination of Reaction Engines' transformer heat exchanger technology and STFC's innovative catalysts will start a new class of fuels based on air propulsion systems that will use green ammonia," says Dr. James Barth, chief engineer at Reaction Engines. "This study showed that an ammonia-powered jet engine could be adapted from currently available engines, while ammonia as a fuel does not require a complete reconsideration of the design of civil aircraft as we know them today. In this way it will be possible to make a rapid transition to a future of sustainable aviation at a low cost; ammonia-powered aircraft could serve the world's short-haul routes probably long before 2050."

The plane of the future will be faster, quieter and more comfortable, lighter, and safer because various components will be made entirely of woven carbon carpets embedded in plastic called "composites". These materials offer both lightness and exceptional strength. Smooth, rivet-free surfaces ensure superior aerodynamics (Figure 42).



Figure 42: A Voestalpine concept

Source: <https://www.voestalpine.com/blog/en/mobility/aerospace/all-set-for-the-future-new-aircraft-technologies-are-taking-to-the-skies/>

A model of the Tempest jet fighter has been unveiled by the defense secretary, Gavin Williamson, at the Farnborough airshow (Figure 43).

The Secretary of Defense has revealed plans for a new RAF fighter jet, Tempest, which will eventually replace the Eurofighter Typhoon.

In the Farnborough air show, Gavin Williamson unveiled a conceptual version of the sixth-generation fighter jets that the Ministry of Defense (MD) expects to take out of the new air combat strategy, meant to maintain Britain's status as such "A military power after Brexit".

This is a strategy to maintain air control, both at home and abroad, to remain a global leader in the sector, "said Williamson.

A world leader in the air combat industry for a century, with a range of envied by skills and technology, and this strategy clearly shows that we are determined to make sure it stays that way."



Figure 43: A model of the Tempest jet fighter, unveiled by the defense secretary, Gavin Williamson, at the Farnborough airshow

Source: <https://www.theguardian.com/uk-news/2018/jul/16/uk-tempest-fighter-jet-typhoon-farnborough-airshow>

The government has said it will spend £ 2bn on aircraft development between now and 2025, using the money allocated in 2015 for future air combat technologies, but has given no estimate of the overall cost of the Tempest program. Private companies also contribute funds and are believed to have spent hundreds of millions on planes so far. Tempest will be able to fly unmanned, according to plans launched by MoD, and will have onboard the new generation technology designed to face modern threats.

This will include "swarming" technology that uses artificial intelligence and machine learning to reach their targets, as well as targeted energy weapons (DEWs) that used concentrated laser blasts, microwave ovens, or particle beam energy to cause damage. Tempest will be built by a consortium led by British defense company BAE Systems, with engine manufacturer Rolls-Royce, Italian aerospace company Leonardo, and pan-European missile manufacturer MBDA.

At the 2011 Paris Air Show, aerospace giant EADS unveiled a fully electric propulsion system for a commercial aircraft that could be ready to fly in just 20 years. The aircraft, called the Voltaire, is a zero-emission, high-density, battery-powered aircraft that rethinks the design of conventional commercial aircraft to allow the change of the heavy-jet engine for an environmentally friendly battery system.

The aircraft is powered by high-efficiency superconducting electric motors that operate reverse spiral propellers located behind the aircraft. The significance of this aircraft is not focused on the engineers' decision to sink a battery inside, but on the EADS team's

understanding that in order to make electric airplanes a reality we will have to rethink not only engines but also aircraft propulsion systems and design (Figure 44).



Figure 44: EADS Rethinks the Way Planes Fly With New All-Electric Aircraft Design
Source: <https://inhabitat.com/eads-rethinks-the-way-planes-fly-with-new-all-electric-aircraft-design/>

EADS has thought of building the Voltaire project with two large batteries, each with a very high density, which is positioned in the hold so that they can be easily changed when the plane arrives at an airport. The discharged batteries will then be returned to a charging station in the same way that cargo and luggage are removed from an aircraft - a set of fully charged batteries to be replaced so that the aircraft does not waste time waiting to charge the batteries, so they are very easy to replace, wherever the plane will land.

The rear propulsion system together with electric motors achieves great fuel economy, eliminates the huge noises of propulsion on classic fuels, fossil fuels, eliminates environmental pollution with already known classic pollutants that have completely destroyed nature's ecosystems thus achieving all dreams of humanity to fly smoothly without noise and noxious substances, without environmental pollution, without stress, and in great safety, with a much high quality of flight. The proposed system aims to bring with it the success that the industry has had in the last 10 years, and the batteries they need - 1000 Wh / kg - in no more than 20 years, which would completely change the way they fly.

It is already hoped that flights to Australia and the US will soon be able to be made much faster in just a few hours, thanks to a new super powerful aircraft engine. Thus the British could arrive in New York in just an hour's flight with a plane powered by new technology (Figure 45).



Figure 45: British could arrive in New York in just an hour's flight with a plane powered by new technology

Source: <https://www.express.co.uk/travel/articles/1182994/flights-plane-engine-rocket-new-york-australia-reaction-engines-news>

Flights could be very fast in the coming years, thanks to a very powerful new engine. The flight to New York could take just an hour, and a trip to Australia could be completed in four hours with the new technology. The British company Reaction Engines is creating the super-engine that could see tourists throwing themselves around the world at full speed. The technology company said it intends to offer a "truly versatile propulsion system". It will be "an air-breathing hybrid rocket engine that can power an aircraft from a permanent start at a speed of sound five times faster for hypersonic flight into the atmosphere."

The engine is nicknamed the Engine of the Synergistic Breaking Air Missile (SABRE) and "represents a defining moment in motor flight". It will also power spaceships.

The British company Reaction Engines Ltd believes that its engine called the Sabre could be integrated into the fuselage of a spacecraft onboard which would function like an atmospheric jet engine and like the propellers of a rocket in space. Gear could take the place of rockets in terms of space travel and could revolutionize flight, minimizing air travel time.

In the preliminary tests that took place yesterday, the European Space Agency (ESA) said it was satisfied with the parameters and performance of the Sabre engine. The Skylon spacecraft exists only in the concept phase, and what the British company has at the moment is a very efficient heat exchanger, capable of cooling the aspirated engine air at very high speeds, from 1,000 degrees C to 150 degrees Celsius, in a hundredth of a second, all without freezing the components, which would damage the mechanisms.

This essential technological implementation solves one of the basic constraints that limit jet engines to a maximum speed of about 2.5 times the speed of sound, a value that Reaction Engines engineers believe their engine can double. The Sabre engine could

therefore move an aircraft through the air with five times the speed of sound, at an altitude of 25 km, about 20% of the speed and altitude needed to reach the orbit of the planet. To get into space, Sabre engines would switch to rocket mode to make up for the remaining 80 percent.



Figure 46: Skylon aircraft with the super motor Sabre

Source: <https://www.b1.ro/stiri/high-tech/avionul-skylon-dotat-cu-cel-mai-avansat-motor-cu-reactie-ar-putea-ajunge-in-spatiu-43792.html>

We also talked about the super-powerful Sabre engines when we presented the engines of the Skylon aircraft (Figure 46), so it was normal to mention these super motors of their future, their more evolved descendants, and the endowment with such advanced engines continuous to other ultrafast super aircraft.

Current jet engines can only power a vehicle up to Mach 3, three times the speed of sound, Reaction Engines explains on their website. A Mach number is a dimensionless quantity representing the ratio of flow velocity past a boundary to the local speed of sound.

SABRE engines are capable of Mach 5.4 in air-breathing mode and Mach 25 in rocket mode for space flight (Figure 47).



Figure 47: SABRE engines are capable of Mach 5.4 in air-breathing mode and Mach 25 in rocket mode for space flight

Source: <https://www.express.co.uk/travel/articles/1182994/flights-plane-engine-rocket-new-york-australia-reaction-engines-news>

“They are simply going to revolutionize the way we travel around the globe, and into orbit,” said Reaction Engines.

“Like jet engines, SABRE can be scaled in size to provide different levels of thrust for different applications which are crucial to our success – it's going to enable a whole generation of air and space vehicles.”

Soon we will be able to forget about fuel tanks and batteries or accumulators, thanks to a new concept of the electric jet that uses air friction (friction of the ship with air) in order to generate energy. Instead of fossil fuels or large, bulky, heavy batteries, the Eather One will be powered by air friction over the wings and frame. This type of renewable energy on demand is a radical proposal (Figure 48).

While the latest trend in business aviation is the creation of the next generation of electric and hybrid aircraft, a new type of space race could emerge if physics actually supports the theory behind Eather One.



Figure 48: Eather One will be powered by air friction over the wings and frame. This type of renewable energy on demand is a radical proposal.

Source: <https://robbreport.com/motors/aviation/business-jet-air-friction-power-2905135/>

Designer Michal Bonikowski's concept is probably four or five generations ahead of the current way of thinking, but Bonikowski told Robb Report that he was inspired by Airbus' recent Maveric concept. "The unique design of the aircraft helps reduce traction while providing more cabin space," he said. "I've been thinking about this a lot lately and I wonder what could happen if a big company wanted to create an electric plane."

What came with the Warsaw designer is potentially revolutionary. Eather One uses air friction and high jet speed as the main source of renewable energy on demand.

Although it looks like a future aircraft, the main difference between Eather One and contemporary hybrid aircraft are winged triboelectric nanogenerators. Nanogenerators

convert mechanical energy directly into electricity. The aircraft does not need large tanks or batteries, because it will generate electricity from the air molecules in the troposphere and stratosphere.

As Eather One travels at high speeds, Bonikowski's idea is to capitalize on the friction generated by the vibrations inside the aircraft and the bending of the wings. The converted energy will power the electric motors and recharge the batteries. This light source means that the Eather One will require smaller battery packs than aircraft that rely on the stored battery.

China briefly presents a new special, secret, prototype with UFO shapes, with special capabilities (Figure 49).



Figure 49: Weirdest is e new aircraft. China briefly presents a new special, secret, prototype with UFO shapes, with special capabilities.

Source: <https://www.youtube.com/watch?v=miEwfK5VVEU>

Flight of the Future is Science Fiction or a Reality? Laser aircraft will become normal in the future, flying at the speed of light, or very close to it, so that later this limit can be exceeded, the speed of movement becoming much higher than that of light, which will become only a lower limit from which space ships will accelerate, traversing galaxies at superluminal speeds. In Figure 50 one can see a laser aircraft.



Figure 50: A top secret US laser aircraft

Source: <https://www.youtube.com/watch?v=qn2x62G5GmM>

3. RESULTS AND DISCUSSION

An ion propeller (Figure 51) is a form of electric propulsion used to propel the spacecraft that produces propulsion force by accelerating ions. Such an ionic impeller is classified according to the ion acceleration mode by the use of electrostatic or electromagnetic force. It should point out that electromagnetic ion propulsion engines actually use Coulomb's force accelerating the ions in the direction of the electric field (Petrescu et al., 2018o; 2020).

Electromagnetic ion thrusters use Lorentz force to accelerate ions. The term "propellant ionizer" usually refers to electrostatic fields or networks. The first fact that needs to be pointed out and even pointed out to a propulsion produced with ion thrusters is that such a propulsion is generally very small in strength and acceleration compared to a chemical propulsion for example, from a conventional rocket, but instead by such propellers with ionic impellers a very high specific impulse (propulsion power) can be obtained, i.e. the propulsion made by a certain amount of fuel or energy consumed is more efficient compared to the classical chemical one, thus achieving a higher flight autonomy, and increased energy autonomy, which can lead to a smaller fuel or energy tank with greater flight autonomy.

In fact, the biggest problem for any aircraft and especially for space aircraft is precisely the heavyweight and huge volume of the fuel tanks, which often leads to the use of old rocket systems in stages that after consuming a fuel step will throw practically that step, which leads to the need for the construction and use of modular ships to throw some of its modules during flight, obviously to space aircraft, but also to modern aircraft that still need large spaces for fuel tanks, which often they have to be hidden in the wings of the plane to gain some space inside the aircraft itself.

In other words, these initial sources of ionic propulsion have the great advantage of a relatively higher specific power. The parent of the concept of electric propulsion is Konstantin Tsiolkovsky, who first published a reference to this idea in 1911. But the first specification of an electric propulsion system appeared in Robert H Goddard's book, September 1906. Ion Driving Experiments were practically developed by Goddard at Clark University from 1916-1917 (Petrescu et al., 2018o; 2020).

The technique is only recommended for high altitude flight in a vacuum, and the force achieved by such impellers has been demonstrated with ionized air flows under atmospheric

pressure. The primordial idea should, in fact, be attributed to the father of the missiles Hermann Oberth from *Wege Zur Raumschiffahrt*, published in 1923, where Hermann explains his thoughts on the massive propulsion economy, predicting its use in propulsion and controlling the attitude of the spacecraft using the gas-charged with electrostatic acceleration.

A first ion propulsion system was actually built by Harold R. Kaufman in 1959, at the headquarters of NASA's Glenn Research Center, and looks somewhat similar to the general design of already known mercury fuel. Suborbital tests of the engine followed (1960) so that in 1964 the engine would be sent on a suborbital flight aboard the Space Electric Rocket Test 1 (SERT 1). It worked well with 31 plans before returning to Earth, representing a real first success.

The workings of the Hall Effect have been studied independently both in the US and in the USSR in the 1950s and 1960s (Petrescu et al., 2018o; 2020), but the development of a Hall propulsion concept has actually been achieved only in an efficient Union propulsion system Soviets (Figure 52a), while in the US, scientists have instead focused on the development of ionic propellants. The Hall Effect projectors were operated on Soviet satellites from 1972 until the 1990s, being used mainly for satellite stabilization in the North-South and East-West directions.

The first thus about 200 engines ended their mission on Russian and Soviet satellites by the end of the 1990s. The first Soviet pilot project of this kind introduced in the West in 1992, was realized after a team of specialists in electric propulsion, benefiting from the support of the Rocket Defense Organization, visited the Soviet laboratories (Petrescu et al., 2018o; 2020).

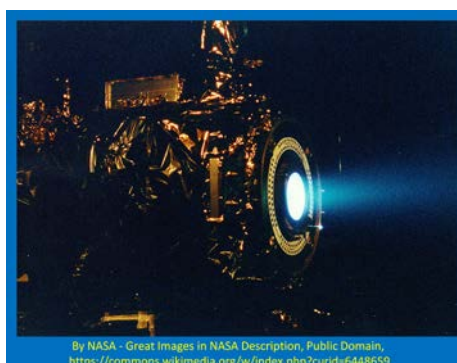


Figure 51: NASA's 2.3 kW NSTAR ion thruster during a hot fire test at the Jet Propulsion Laboratory on the Deep Space 1 spacecraft.

Source: Petrescu et al. (2018o; 2020)

The method by which the ions are accelerated for the purpose of their use as propulsion in aircraft varies, but all the models already presented are based on the charge / mass ratio of the ions (report showing that relatively small potential differences can create good escape velocities).

As we have already specified the use of such propulsions reduces the amount of mass of reaction or fuel required, and increases the amount of specific power required compared to the classic, chemical rockets, but with the disadvantage that they cannot yet achieve sufficiently high powers and the very high acceleration required especially when taking off, landing, or when the aircraft wants to accelerate suddenly (Petrescu et al., 2018o).

The ionic bands proposed for use are thus capable of obtaining extremely high specific impulses, with the disadvantage of the slow acceleration of the spacecraft, because the mass of the current electrical units is directly correlated with the amount of energy given, a parameter called push (reduced). This low pressure makes these electric push-button devices not suitable for launching the spacecraft into orbit, but they may even be ideal for space applications.

The different ionic thrusters that have been designed so far can fall into two important categories: electrostatic or electromagnetic. The main difference between them is how the ions are accelerated. Electrostatic propulsion engines use Coulomb force and are classified as accelerating ions in the direction of the electric field.

The electromagnetic ion gates actually use the Lorentz force to accelerate the ions. Electrostatic ion propulsion jets generally use xenon gas (Figure 52b), which has no charge but is ionized by bombardment with energy electrons, which can be fed from a filament with a hot cathode and then accelerated into the electric field the cathode, which enters the anode (see the case of a Kaufman propeller) (Petrescu et al., 2018o; 2020).

Alternatively, electrons may also be accelerated by the oscillating electric field induced by an alternating magnetic field of a coil, which results in self-sustained discharge thus omitting any cathode (radio frequency ionic propellant).

The positively charged ions are then extracted through a 2 or 3 grid extraction system.

After their entry into the network system through the plasma sheath, the ions will be able to be accelerated by a potential difference between the first network and the second

potential (the screen called the acceleration grid) until the final ionic energy of about 1-2 keV, thus generating the pulling or pushing force.

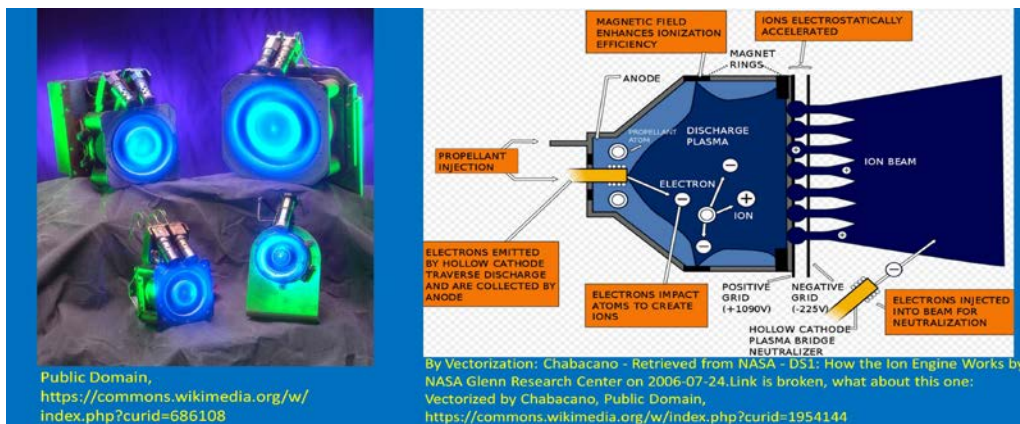


Figure 52a: Russian Hall Effect thrusters Figure 52b: Gridded electrostatic ion engine
 Source: Petrescu et al. (2018o; 2020)

In order to avoid the charge of the spacecraft a different, additional cathode is placed near the electron-emitting engine (basically the electron flux is the same as the ion flux) in the ion beam, which prevents the ion beam from returning to the spacecraft and therefore prevent the possibility of canceling the propulsion force.

Analysis of electrostatic ion propulsion (past / present): NASA Solar Propulsion Technology (NSTAR); Development of NASA's evolutionary xenon (NEXT); Nuclear Xenon System (NEXIS); High power electric propulsion (HiPEP); EADS with radio frequency radio transmission (RIT); Dual-Stage 4-Grid (DS4G); Effect Hall Effect.

The greenhouse projectors (Figure 53a) can produce ion acceleration using an electrical potential maintained between a cylindrical anode and the negatively charged plasma that actually represents the cathode. The xenon gas is introduced somewhere near the anode for ionization, then the ions are attracted to the cathode, which is accelerated much pass through the device, which collects electrons allowing them to neutralize the beam and then launch it with big speed. The anode is positioned at one end of the cylindrical tube, and in the center is a peak that is wound to produce a radial magnetic field between it and the surrounding tube.

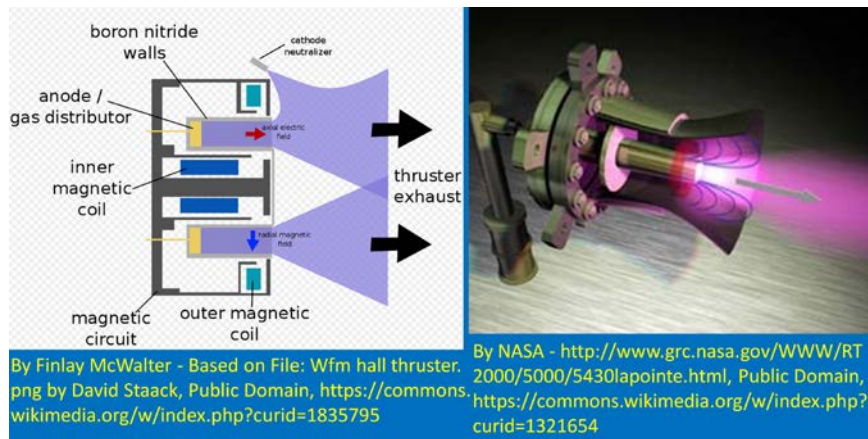


Figure 53a: Schematic of a Hall Thruster [14]. Figure 53b: A CGI
 Source: Petrescu et al. (2018o; 2020)

Ions are not greatly affected by the magnetic field being too massive, but the electrons produced near the tip (to create the cathode) are completely affected by being trapped by the magnetic field held in place by their attraction to the anode. Some of the electrons will spiral toward the anode. When they reach the anode, they affect the uncharged propellant and practically produce its ionization before finally reaching the anode and thus closing the entire circuit (Petrescu et al., 2018o; 2020).

Generally, the gaseous fuel is ionized and introduced into an acceleration chamber, where the magnetic and electric fields are created using a power source. The particles will then be effectively propelled by a Lorentz force resulting from the interaction between the plasma flow current and the magnetic field (externally applied, or induced by the current) through the escape chamber (Petrescu et al., 2018o; 2020).

Unlike chemical propulsion, there is no more combustion of fuel here. As with other variations of power transmission, the impulse force, and the traction force increase with the input power, while the traction force per watt is practically reduced. There are two main prototypes of MPD propellers, the applied field and the field itself (Figure 53b).

It is important to differentiate between the field propulsion devices that have magnetic rings that surround the exhaust chamber for the purpose of producing the magnetic field and the field propulsions that are equipped with a cathode that extends through the middle of the chamber. The applied fields are required for low power levels at which the field configurations are too weak. In general, different models of propellant elements such as xenon, neon, argon, hydrazine, and lithium have been used, lithium being generally the most efficient.

VASIMR (Figure 54a) represents a different engine that offers a similar level of performance as an MPD, working on a totally different principle: it is an electrothermal device to which the energy is first applied helically to increase its temperature (thermal energy). At VASIMR the propeller is heated by RF and then part of the thermal energy content of the propellant is converted into direct kinetic energy using a suitable nozzle, (for the model in Figure 54b a magnetic nozzle is used) (Petrescu et al., 2018o; 2020).

Theoretically, MPDs could produce extremely high pulses (Isp) with an escape velocity of even over 110,000 m / s, triple compared to a xenon propulsion and about 20 times higher than that achieved by rockets with liquid fuel.

MPD technology has the potential to reach voltages up to 200 Newton, which is much higher compared to all types of electric propulsion used to date and about as large as most interplanetary chemical rockets.

This exciting fact could also allow for quick maneuvers in missions that require fast delta-v maneuvers (such as capturing orbits around another planet), but this time with much higher efficiency compared to conventional (chemical) fuels).

For this reason, MPD technologies have been studied extensively academically, but commercial interest has been shown to be extremely low due to the large technical problems raised by such a system, which are still generally unresolved.

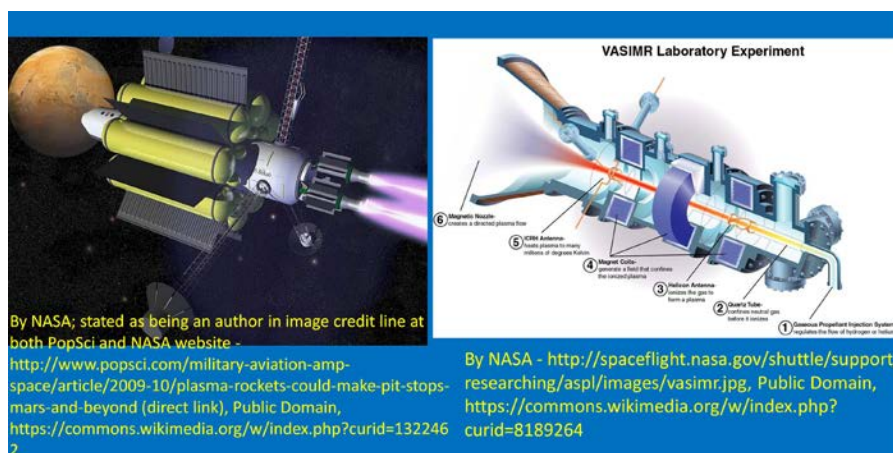


Figure 54: Several VASIMR engines propelling a craft through space.
 Source: Petrescu et al. (2018o; 2020)

The first real problem of the system is that of providing a minimum power requirement of hundreds of kilowatts useful for obtaining minimum performances by such a propulsion system because the current systems of interplanetary spacecraft (such as

radioisotopic thermoelectric generators (RTG)) and solar networks are not yet capable of delivering such high energy (Petrescu et al., 2018o; 2020).

There was a lot of talk at the time about a NASA project "Prometheus" capable of generating energy in hundreds of kilowatts, but it was abandoned or interrupted in 2005, without specifying if it failed to achieve the parameters initially promised, or it was a financial problem, but maybe just one of his successes led to his passing to strict secrecy, making the project seemingly abandoned but continued in secret. More data is not yet publicly known.

Perhaps it should be noted that there was also a Soviet project to build a space nuclear reactor capable of generating 600 kilowatts of electricity actually started in 1963 in the USSR, but that was eventually abandoned.

Plans for the development of an industrial nuclear reactor capable of being used on space aircraft were announced in 2009 by the Khrushchev Institute of Russia, the Roscosmos National Agency, also confirmed by the Russian President in November 2009.

Another plan in the field is that proposed by Bradley C. Edwards, on power transmission from the ground, using 5,200 kW at 0.84 microns with Optical Field Adaptive to be able to transmit power to a spacecraft powered by an MPD system where transforms into GaAs photovoltaic energy. Adjusting the wavelength of a 0.840-micron laser and a photovoltaic panel of 1.43 eV (1.48 eV / photon) together would generate an estimated conversion efficiency of 59% and an estimated power density of up to 540 kW / m², would allow the use of a larger MPD, at least to initially raise the satellites from LEO to GEO.

Another major problem of MPD technology is the rapid degradation of the cathode used on the ship due to the high working current densities (over 100 amps / cm²), evaporation of a part of the cathode. The attempt was made to replace the lithium with a mixture of lithium carbide and barium carbide and the construction of a cathode with channels (multichannel cathode), which under laboratory conditions could demonstrate the cathode erosion.

The authors of the present paper have shown in various articles that stronger propulsion for space aircraft should have a power greater than that achievable by an MDP system, for which the theoretical use of stationary particle accelerators has been proposed so far, further, leading to the construction of mobile circular reactors, related to the ship. The

authors believe that the future (ionic) motor will necessarily have a circular particle accelerator (high or very high energy). Of course, the difficulties will come from the project, but they can be solved in time step by step.

However, through such a system, the autonomy of the ship can be greatly increased, the speed and maneuverability of the ship, its stability, the possibilities of accelerations and decelerations regardless of the situation, by using a small quantity of fuel. Synchrotron radiation (synchrotron light, high-intensity beams, Figure 55) can also be used, such as high-intensity radiation (X-ray or Gamma-ray), in which case the accelerated beam that will propel the ship will no longer be an ionic one but one that will contain radiation of various types, classifiable according to their frequency (Petrescu et al., 2018o; 2020).

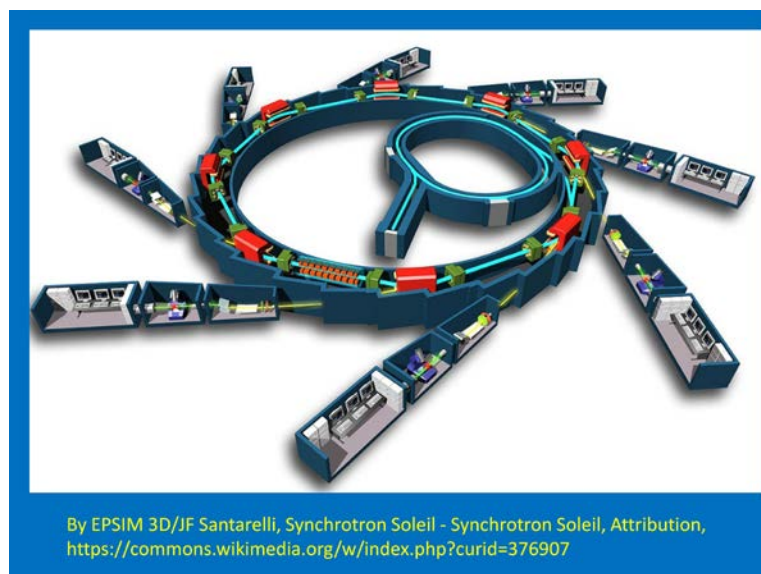


Figure 55: A high energy synchrotron schema.
Source: Petrescu et al. (2018o; 2020)

Linear accelerators have great problems with the ground due to the size needed to create at their output very high desired power or energy but combined with circular ones they could also be useful in the construction of future spacecraft. In the case of particle accelerators of this type, very powerful would not pose any problem regarding the power or the energy of the ejected ions that will give the impulse of the aerospace ship, being already about energies not of kW, nor of MW, but GW, or even TW or PW.

There are enough difficulties in stationary particle accelerators, which according to the corresponding author of the present work are far behind the current needs of the planet, but as we can see recently they have begun to be improved more and more, and in the foreseeable future could meet the demands of a modern aerospace ship.

Here the problems (especially speaking of the circular particle accelerators) refer in particular to the large dimensions required today to achieve a strong acceleration of the elementary particles, even though for many decades the pattern of successive passing many times and the increase of energy has been practiced, through as many such passes at the expense of increasing the diameter of the circular accelerator as it was initially done. But there are many other physical problems, but especially electronic devices and technologies, which are being solved more and more quickly and correctly in these times and give us high hopes.

The largest and most powerful particle accelerator at present is CERN, RHIC, Large Hadron Collider (LHC) and Tevatron (Figure 56) used for experimental particle physics.

Recently, it used an injector in a higher energy synchrotron in an experimental laboratory dedicated to particle physics. In this sense, the large classic synchrotron is reduced to an annular surface (magnetic core) (PETRESCU et al., 2018o; 2020).

On September 13, 2007, researchers at the University of Cardiff, led by Professor Tim Wess, discovered that Diamond Synchrotron can be used to uncover the hidden content of ancient documents through the light without opening them (penetrative layers of parchment).

A synchrotron like this, the size of a stadium, built as a flight ship, could carry from 30,000 to 50,000 passengers!



Figure 56: The Tevatron (background).
Source: Petrescu et al. (2018o; 2020)

For some applications, it is useful to store high energy particle beams for a certain amount of time (with modern high vacuum technology up to several hours) without additional acceleration, procedure named the “storage rings”.

This is especially true for beam collision accelerators, in which two strips moving in opposite directions collide with one another with a high gain in effective collision energy (Petrescu et al., 2018o; 2020).

Since there is a relatively small collision at each intersection of the two beams, the beam acceleration energy is a common destination and then stored in the storage rings, which are essentially synchrotron magnets that accelerate the power.

By storage, the ring is meant a circular particle accelerator used for the storage over a certain period of a continuous or a pulsatory particle beam maintained in circulation for a longer period of time, approximately up to several hours. The storage of a single elementary particle depends on its ordinary mass, energy, and load. Generally, such storage rings are used to store electrons, positron or protons.

The most used application of the storage rings is the one that stores electrons which then radiates synchrotron energy.

At present, there are over 50 electronic drum compartments, used in a wide variety of studies in chemistry and biology, or nuclear physics. The storage rings are also used in the production of high polarization electron beams through the Sokolov-Ternov effect, but their most popular application is that of nuclear collision physics in particle accelerators and particle collisions, in which two accelerated counter-rotating particles occur. They collide in discrete places, the results of subatomic interactions being then studied in a particle of the clean detector. Examples of such installations are LHC, LEP, PEP-II, KEKB, RHIC, Tevatron and HERA.

Practically, from a technical point of view, a storage ring is like a kind of synchrotron. However, a conventional synchrotron is more generally used to accelerate low energy particles often working on a radio frequency; a storage ring, as it is known, keeps the particles at a constant energy, the radio frequency cavities being used here only for the purpose of replacing the energy lost through the synchrotron radiation and other related processes in the respective installation.

An essential advantage of special storage rings is that the storage ring could accumulate a greater acceleration of the injection beam at a much higher rate. For particles to move in a circular path, a force consisting of electrostatic or dipole magnetic fields is required, but since most storage rings retain relatively particles, it is more useful to use magnetic fields produced by dipole magnets (Petrescu et al., 2018o).

Electrostatic accelerators are intended for the storage of very low energy particles, while quadrupole fields can be used for neutron storage.

Diploid magnets achieve only weak focal points and a storage ring composed only of these types of magnetic elements will generate large beam particles, which is why dipole magnets intersect with an appropriate arrangement of quadrupole and sextupole magnets, in order to achieve a stronger focusing system that is capable of producing a much smaller beam when needed (Petrescu et al., 2018o; 2020).

The FODO and Chasman-Green zoning structures are just a few simple examples of powerful focusing systems, but there are others of this type.

Dipoles and quadrupole magnets define the energies of the particles in different quantities, a property called chromatic analogous to optical physics.

The spread of the energies inherent in any stored particle beam will practically lead to a spread of the transverse and longitudinal focusing, but also to instabilities of the particle beam (Petrescu et al., 2018o; 2020).

Six magnets (and larger magnets) will be used precisely to correct this unwanted phenomenon, but they will, in turn, generate non-linear movements, which is another big problem facing storage ring designers.

Due to the fact that a pulse (a group of accelerated and stored particles) will travel millions of kilometers (at almost the speed of light, for several hours), any gas or residual element in the beam can cause unwanted collisions, which will increase the spread of energy pulse kept. Therefore, the better the vacuum system is used, the better the system will work and the obtained file will be much more appropriate.

Synchrotronic radiation is the most massive part emitted by light particles, and for this reason, this type of accelerator will only accelerate electrons. Synchrotron radiation can generate a better image, being developed by researchers from SLAC SPEAR.

So practically a synchrotron light source represents a source of electromagnetic radiation that can be generated within a synchrotron for various technical-scientific purposes, usually being accelerated electrons. When a high-energy electron beam has been generated, it will be sent to auxiliary devices, such as bending magnets and induction devices (induction or winding), to electronic storage rings and lasers, as they can provide strong magnetic fields perpendicular to the beam, which will convert high energy electrons into light or other electromagnetic radiation (Petrescu et al., 2018o; 2020).

4. CONCLUSIONS

Aircraft manufacturers are constantly concerned with modifying their aircraft and building other new models that meet customer requirements as much as possible, but at the same time lead to reductions in total fuel consumption used in flight, to reduce pollution due to flights and the negative effects on planetary ecosystems, as well as the increase in the quality and safety of air travel.

For these reasons, new and new models, concepts, and then new aircraft are constantly appearing, which today integrate very quickly in air traffic, an important additional requirement being that of ensuring increased autonomy and achieving high travel speeds to shorten real travel times especially on very long and tiring routes.

The introduction of hydrogen fuel is today a major requirement that must be solved correctly and in a timely manner by major aircraft manufacturers, in order to eliminate the emissions produced by aircraft.

Sooner or later, hydrogen will become the number one fuel for aviation and aerospace, whether it is burned or used as a raw material to obtain nuclear fusion energy directly on the spacecraft. Hydrogen is practically the future source of energy and the key to successfully solving the energy problem in aerospace and aviation but also in other industrial and civil fields.

EADS has thought of building the Voltaire project with two large batteries, each with a very high density, which is positioned in the hold so that they can be easily changed when the plane arrives at an airport. The discharged batteries will then be returned to a charging station in the same way that cargo and luggage are removed from an aircraft - a set of fully charged batteries to be replaced so that the aircraft does not waste time waiting to charge the batteries, so they are very easy to replace, wherever the plane will land.

The rear propulsion system together with electric motors achieves great fuel economy, eliminates the huge noises of propulsion on classic fuels, fossil fuels, eliminates environmental pollution with already known classic pollutants that have completely destroyed nature's ecosystems thus achieving all dreams of humanity to fly smoothly without noise and noxious substances, without environmental pollution, without stress, and in great safety, with a much high quality of flight.

The proposed system aims to bring with it the success that the industry has had in the last 10 years, and the batteries they need - 1000 Wh / kg - in no more than 20 years, which would completely change the way they fly.

Although it looks like a future aircraft, the main difference between Eather One and contemporary hybrid aircraft are winged triboelectric nanogenerators. Nanogenerators convert mechanical energy directly into electricity. The aircraft does not need large tanks or batteries, because it will generate electricity from the air molecules in the troposphere and stratosphere.

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5. AUTHORS' CONTRIBUTION

All the authors have contributed equally to carry out this work.

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