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Review Article

The Future of Land, Waterway, Air and Space Transportation Means

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Abstract

This article aims to present the major innovations that are expected to occur in land transport (urban, road and rail), waterway transport, air transport and space transport in the future.

Keywords: The future of transportation means; land transport (urban, road and rail) of the future; waterway transport of the future; air transport of the future; space transport of the future

Introduction

This article aims to present the major innovations that are expected to occur in land transport (urban, road and rail), waterway transport, air transport and space transport in the future. The evolution of means of transport was essential for the development of humanity. Means of transport have been used throughout history, whether to acquire food, carry out construction, cross-rivers and oceans, wage war, transport people and goods and conquer air and outer space, etc. As humanity evolved, means of transportation changed. Land transport, as well as water transport, has existed since the beginning of humanity. The domestication of animals introduced a new way of placing the weight of land transport on stronger animals, allowing heavier loads to be transported, with greater speed and shorter journey times. Horses, camels, oxen or even human beings were used as means of land transport on dirt roads. With the invention of the wheel, the means of transport were no longer just animals but also carts, pulled by oxen or horses, which intensified the development of means of transport. From that moment on, part of humanity acquired the ability to transport more goods and people quickly. Paved roads were built by many ancient civilizations. To this day, the wheel has fundamental importance in our daily lives. There are wheels on cars, planes, motorcycles, skateboards, roller skates, carts, bicycles, etc. It was only after the 1st Industrial Revolution (18th century), that the quantity and efficiency of means of transport expanded, with the advancement of science and technology. From the invention of the steam engine, the locomotive was developed, which enabled the development of the railway, which quickly spread throughout industrialized nations and the rest of the world.

The only mode of transporting cargo in foreign trade in the 15th and 16th centuries was waterway. The Sagres School in Portugal developed, in the 15th century, the construction technology for caravels as well as the seamanship and navigation techniques, necessary for the great voyages of discovery. This type of navigation was used primarily by humanity, until the emergence of steam navigation. The spread of the invention of the steam engine led to the dream of moving large vessels without depending on the winds. It was from the 19th century onwards that steam vessels appeared and later with engines powered by petroleum derivatives. Ships are increasingly being produced to transport cargo in large volumes and specifically for each type of cargo, in addition to using them as weapons of war. With the development of steam ships, the subway that began operating in London in 1863 and the inventions of the bicycle between 1817 and 1880, the airship in 1852, the elevator in 1853, the electric tram in 1881, the automobile in 1885, the motorcycle in 1885, trucks in 1895, airplane in 1905, helicopter in 1907, space rocket in 1925, drone in 1977, among other inventions, there was a true explosion of possibilities in the field of transport. All these means of transport include means intended for transporting people or cargo. Means of transport can be classified as land, waterway, air and space.

Land means of transport travel on city streets, dirt roads, paved highways and railways using trains, electric trams, urban elevators, inclined planes, cable cars, buses, subways, automobiles, trucks, bicycles and motorcycles. Waterways are those that move on water, using canoes, ferries, boats, ships, submarines and aircraft carriers. They are classified as maritime (sea), fluvial (river) and lacustrine (lake). Aerial means of transport are those that move in the air with planes, helicopters, balloons, airships and drones. Space means of transport are those that move through outer space using rockets and/or spacecraft to move astronauts, artificial satellites, space probes, robots, rovers or any other type of equipment for space exploration. Means of transport require appropriate infrastructure and vehicles. By infrastructure it is understood the urban transport network, road network, railway network, waterway network, aerial network, space network, etc. that are used, as well as terminals such as bus stations, railway stations, subway stations, port terminals, airports, rocket launch centers and all types of similar equipment. Vehicles, such as cars, bicycles, trains and planes, among other vehicles, or people or animals themselves when traveling on foot, generally travel through any network. It can be said that means of transport have enabled human beings to occupy all spaces on planet Earth and have contributed decisively to promoting its economic and social development. What will land, waterway, air and space transportation of the future be like? The answers to this question are presented in the topics presented below.

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Land Transport (Urban, Road and Rail) Of the Future

What will future land transportation look like [1-4]? In urban centers, local governments will encourage the use of means of transport that follow the trend of smart and sustainable cities, interconnected by access roads controlled by various devices that use artificial intelligence and the internet of things (IOT) to maintain agile traffic. It's safe. The prioritized means of transport will be subways, trains, bicycles, scooters, walking and Bus Rapid Transit (BRT's). Transport systems will feature technologies such as robotics, internet of things (IOT), applications and more modern collection systems. ITS (Intelligent transportation Systems) solutions will monitor in real time everything that happens in the bus system and will create an interface with other modes of urban mobility. The main function of conventional bus lines will be to connect the most distant neighbourhoods in conjunction with the metro lines.

Drones and flying vehicles will fly over city streets, ensuring greater safety, mobility and speed in the delivery of products and people, respectively [5]. The streets will have extensive cycle paths, in addition to numerous exclusive lanes for BRTs powered by hydrogen, which is considered by the International Energy Agency (AIE) as the fuel of the future, whose biggest challenge is the production of clean hydrogen on a large scale. Widely used, subways and trains will be essential in metropolises. Cities in metropolitan regions will no longer be isolated from capitals, taking into account that high-speed railway lines will cut through several municipalities. Real-time monitoring will allow control of traffic light intervals, according to traffic flow, to avoid congestion. The information will be displayed at train and bus stops, public parking lots and displays in various locations. People will be able to plan, even at home, the use of different modes of transport, thanks to the evolution of applications, including the famous Global Positioning System (GPS).

The metro will be the main means of public transport in large cities, which will significantly reduce greenhouse gas emissions. One of the technologies used by this means of transport will be hyper loop, which will allow many people to move over a long distance in a short space of time. Trains will magnetically levitate in airless tubes, reaching speeds of 240 mph to 720 mph, and will connect different neighbourhoods in metropolises, often supplying cities in metropolitan regions. Comfortable trains with fast speeds will be common and will avoid motor vehicle congestion on highways. Most railway lines in the world's main capitals will be powered by renewable energies such as solar photovoltaic and hydrogen.

The driverless system, that is, without a driver, will be fully operational. Subways, trains and buses will be driven remotely using software, providing greater safety, speed and comfort for passengers, as it will be possible to control the speed, the interval between them, and even the time the doors are opened. Using the driverless system, it will be possible for the subway to reduce the intervals between one train and another and increase passenger capacity. Furthermore, perfect synchronization of trains will avoid sudden stops and contribute to reducing energy consumption. Trains will be powered by solar energy and hydrogen with the abandonment of diesel from the railway network. Transport companies and suppliers will use resources such as artificial intelligence, internet of things, network speed and big data with the aim of enabling more effective payment systems and the integration of modalities so that subways and buses can be used more widely by the population.

Trains that operate at speeds of more than 200 kilometres per hour can be considered high-speed. The first high-speed [8-9] rail system began operations in Japan in 1964 and was known as the bullet train. Twenty-seven countries around the world currently have high-speed trains, with trains that can reach more than 400 km/h. The continents of Asia and Europe have the largest fast railway networks that transport passengers and cargo. In South Korea, there are a total of 1,104.5 km of tracks for fast trains, with a further 425 km expected soon. The maximum speed for trains in regular service is currently 305 km/h. Turkey is 621 km long, the expansion of which will take the country to more than 2,000 km of tracks for fast services with trains operating at speeds of up to 250 km/h or 300 km/h. Italy is 1,467 km long and trains are operated at a maximum speed of 300 km/h. In the United Kingdom, high-speed rail has 1,527 km of track with four railway lines operating at maximum speeds of 200 km/h. In Sweden, many trains operate at 200 km/h with a total of 1,706 km of track for fast services. Japan has 2,764 km of fast train services that reach a maximum speed of 320 km/h. France has 2,647 km of tracks in addition to 670 km under construction. Germany has 3,500 km of lines, both operational and under construction, with trains reaching speeds of up to 300 km/h. Spain has 3,240 km of tracks and trains that reach speeds of up to 310 km/h. China has 35,000 km of high-speed rail.

On railway lines, preventive maintenance will be carried out by autonomous drones, there will be driverless trains traveling safely at high speeds, freight will be automatically sent to its destination and smart technology will be designed to improve the passenger experience and enable ticketless travel. There will be the improvement and dissemination of automatic steering systems on trains, which will further optimize travel times and may put an end to delays. Smart robots will build new railway infrastructure and modernize old ones. Technological advances will also be vital to improving the user experience, providing accurate real-time route information and enabling uninterrupted access to work and entertainment while traveling via 5G wireless internet networks. The exceptionally quiet and efficient magnetic levitation technology employed in the fully automated Transport System will also allow the system to serve as a space-saving and low greenhouse gas emission alternative. The system will operate at speeds of up to 150 km per hour, being able to move up to 180 containers/hour individually and completely electrically [6].

One of the problems of urban transport systems is the lack of coordination between different modes of transport. People want to know how to get from A to B as easily as possible, whether on foot, bike, motorbike, subway, bus, train, Uber or taxi - or a mix of some or all of them. In the past, we didn't have enough data. Now we have. In addition, we will be able to count on our connected smartphones at all times to help us visualize it all. The application would inform you the fastest way to reach your destination by combining all integrated means of transport, be it an electric car, subway, bus or taxi. There will be a proliferation of electric vehicles. Shared, fully electric and progressively autonomous flying vehicles, with the ability to take off and land vertically, will cut through the skies of cities. To this end, the tops of buildings belonging to partner companies in air transport services will function as take-off, landing and fuelling points. People will increasingly use shared and/or private, fully sustainable electric scooters as an alternative to the subway or bus.

The automobile of the future will be increasingly autonomous, more electric, more connected and shared. Electric and autonomous vehicles appear to be the main drivers of the crucial transformation in city transportation. Autonomous vehicles, therefore, already exist and this is not a futuristic project. The idea is to strengthen public transport. So, in a smart city, people can get rid of their cars, which pose a threat to the health of the population by congesting our cities and compromising air quality with the use of fossil fuels. In many countries, buses and other driverless transport systems are being tested as autonomous vehicles. Public or private autonomous vehicles will connect us from our home to a transport hub. There are already driverless buses in the canton of Schaffhausen, Switzerland, which circulate around the city of Neuhausen am Rheinfall picking up and dropping off passengers while navigating traffic . An employee inside the bus can take control of the vehicle from a remote control, in case of any unforeseen circumstances.

In the future, highways will not be as unsafe as they are today. Vehicles will not have drivers and will not emit polluting waste into the air. Highways will be controlled by sophisticated technologies that communicate with cars, extract energy from the Sun, and integrate road infrastructure and GPS systems [7]. The highways of the future are already being designed. The highways of the future will feature advanced solar panels that will generate clean, renewable energy and wirelessly charge moving or parked electric cars. The panels will also have LED lighting and heating elements to melt snow wherever it exists. Electric cars are expected to become common on the roads of the future, as scientific developments will greatly improve the performance of batteries and the potential for increased electricity storage. Fully automated navigation systems will also allow roads to become populated with driverless cars which could change the design and operation of highways and provide safety and environmental benefits. Vehicles will become increasingly “smart”, which, with a combination of the connected vehicle and the Internet of Things, will enable cars to transmit and receive information about traffic, speed, weather and potential safety risks.

Based on the above, the extraordinary advances in land transport technologies that will occur in the future will contribute to the economic and social development of humanity.

Water Transport of the Future

Waterway transport means the use of rivers (river transport), lakes (lacustrine transport) and seas and oceans (maritime transport). The use of boats was one of the first means of transportation invented by man and was crucial for the development of humanity. Since ancient times, boats have been used as a means of transport. In the beginning, canoes were used for fishing and short-distance transport activities. Canoes are considered the first vessels used to transport people and cargo. Over time, sail boats were invented, which moved driven by the force of the wind. The development of vessels and the discovery of new navigation techniques made it possible for human beings to cross rivers, seas and oceans, overcoming long distances in the transport of passengers and cargo, in addition to using them as weapons of war. From wooden canoes to today’s large vessels, such as modern ocean liners, there has been much progress. After the caravels came the first steam ships, which appeared around 200 years ago with vessels using steam engines to move large ships and gave rise to the dream of not depending on the winds. The first steam vessels allowed sea travel to become faster and foreign trade to be expanded. Modern, diesel engines are used on ships [10].

What will water transport of the future be like [11-14]? Ships of the future will be benefited with sophisticated technologies. Smart ships will become an integral part of the reality that surrounds us. Ships already have sonar to prevent collisions with icebergs or methods that provide better use of energy. Experts say that the great revolution of the future in the shipping industry will be the propulsion of ships using LNG (Liquefied Natural Gas). Vessels that use this fossil fuel, one of the cleanest there is, are already a reality and their applicability is increasing year after year. These advances could allow the goal of reducing greenhouse gas emissions by 2050 to be achieved. It is also important to highlight the major advances in the near future in the application of solar and wind energy as an auxiliary source of propulsion, with the installation of rotor sails to generate clean and renewable energy, bringing more sustainability to the sector. There is an expectation that vessels powered by solar energy will be designed, as we see a great advance in the studies of this technology and its applicability on a large scale or even the civil use of nuclear energy as a source of propulsion. The cargo ships will be powered by batteries that use solar and wind energy.

More than 200 years after the first steamship began crossing the ocean, wind energy finds its way back into shipping lanes. Installing “rotor sails” for one of your tankers is one way to reduce fuel costs and carbon emissions. The company behind the technology, Finnish Norse power, says this is the first wind energy retrofit system on an oil tanker. Some ideal applications for using wind and solar energy include cruise boats, tourist catamarans, fishing vessels, offshore supply ships, research vessels, oil tankers, cargo ships, patrol ships, and passenger ships. [15].

The shipping industry has been studying innovations that will inevitably place navigation on a more sustainable level. It is expected that in the next 10, 20 or 30 years, vessels powered by solar energy will appear, as there is great progress in the studies of this technology and its applicability on a large scale. There will even be the civil use of nuclear energy as a source of propulsion and smart ports [16]. New technologies can be added to port infrastructures, based on the concept of industry 4.0 in the automation and digitalization of ports through robotics, big data, and internet of things (IoT), block chain and artificial intelligence. The cargo ships will use batteries that will be powered by solar and wind energy through agreements with companies that operate near the ports where the boats will be docked. There they can be recharged and have their batteries replaced. Cargo ships will be supplied with batteries that will be powered by solar and wind energy through agreements with companies that operate close to the ports where the boats will be docked [17].

Large ships burn heavy oil, a high-sulphur fuel that produces a large amount of sulphur oxide and nitrogen oxide compounds. The CO2 emission of a large ship is equivalent to that of more than 83 thousand automobiles. Since there are 100,000 ships, they pollute as much as 830 million cars. To avoid this problem, global shipping company Maersk plans to install “rotor sails” for its tankers as a way to reduce fuel costs and carbon emissions. The company behind the technology, Finnish Norse power, says this is the first wind energy retrofit system on a tanker [20]. It is worth highlighting the great advances in the applicability of wind energy in ship propulsion. Wind energy, with the installation of rotor sails, generates clean and renewable energy as an auxiliary source of propulsion, bringing more sustainability to the naval sector in the near future. Great advances in reducing fuel consumption are also achieved thanks to more efficient heat recovery systems, types of paint, and even profound changes in the design of ship hulls, all generating fewer greenhouse gas emissions into the atmosphere. Ships will have sophisticated sonar to prevent collisions with icebergs or methods that provide better use of energy. Ships like these will make better use of sea currents and may even prevent further damage to the ecosystem.

In addition to autonomous cars, the turn of autonomous ships may come. A new electric, crewless container ship is being built in Norway by two companies. The electric cargo ship, for short-sea transport, will initially have a crew still present, but, in 2022, the ship will transition to autonomous operation (if it obtains the necessary authorizations). This ship called "Tesla of the seas" will be directed from an on-board control center during the first voyages. It will then be controlled autonomously via GPS. Possible collisions will be avoided using a combination of sensors [18]. The first fully electric, autonomous cargo ship was built in Norway in 2021. The Yara Birkeland will travel from Heroya to Brevik with just three remote control centers overseeing the journey. Yara first developed the concept in 2017 and planned to set sail in 2020, but the COVID-19 pandemic delayed the voyage. It's not the first crewless ship of any kind to venture out, but it is the first all-electric model. She is a vessel with a maximum speed of 13 knots from her two 900 kW propulsion systems and it is important to say that her giant 7 MWh battery will take some time to charge. However, Yara will be worth it for the environmental gains [19].

One of the most sustainable technologies under study is cargo ships without ballast tanks, which aim to provide ship stability by avoiding the discharge of salt water ballast, which when emptied can cause serious environmental impacts due to the insertion of non-native microorganisms, such as, for example, cholera outbreaks and the spread of the golden mussel, which causes serious fouling problems in vessels, pipes and even hydroelectric plants. Regulations for the disposal of such waters have become increasingly restrictive and, in a time of change, vessels that use ballast tanks will be penalized. It should be noted that ships currently use water in ballast tanks to maintain stability, safety and operational efficiency, especially when the ship is not loaded. The change in freighters without ballast tanks consists of replacing the ballast tanks with structural longitudinal "tubes", with admission at the bow and discharge at the stern, which create a constant flow of local salt water and promote the pressure necessary to generate stability of the ship, according to the cargo loaded. The eventual implementation of such technology in shipbuilding could bring positive impacts to the environment and the operational cost of the vessel, since a series of measures and equipment that are currently used to mitigate the risks of dumping microorganisms in other areas.

Air Transport of the Future

The main advantage of air transport is its agility in carrying out long-distance trips in a short period of time. Air transport has a high level of safety, offers less risk of damage to transported goods because handling is less than in other modes, however, it generates a large environmental impact, particularly atmospheric and noise pollution. Air transport is the second safest form of transport in the world after a building elevator. What will future air transport look like? The aeronautical industry is working on the development of several aircraft projects that promise to revolutionize air transport in the coming years and decades. There are supersonic, electric, autonomous planes and even aircraft that look like a giant drone for transporting passengers in urban centers. The search for more efficient ways of flying and transporting passengers through the skies, emitting fewer polluting gases (or even eliminating them) is the aviation industry's biggest challenge for the coming years. This change will require a technological reformulation of the planes. There are studies on electric planes, flying cars, supersonic planes, among other innovations. The electric plane solution does not yet work for large aircraft. What can be built, now, are electric planes with a capacity of just over 10 passengers and a flight range of around 300 km. Another option evaluated in this area is hybrid propulsion, combining conventional and electric engines. Electric planes should not evolve so quickly that they displace jets in the short or medium term. There are already, for example, electric planes used in flight schools and airlines in the sub-regional category that are considering adopting electric aircraft this decade. Electric planes use electric batteries, the "fuel" of this new type of plane, which are quite heavy and inefficient, compared to the high power of jet and turboprop engines. Another electrical source being studied for planes are hydrogen-powered generators, a technology that still needs to mature until it becomes truly viable. There will be an invasion of VTOLs (acronym in English for Electric Vertical Take-off and Landing Aircraft) called "flying cars" as an alternative for urban transport.

There will be a return to manufacturing supersonic passenger planes. Boom Technologies and Aerion Corporation are working on designs for new supersonic passenger planes [21]. Boom has the proposal that comes closest to what the Concorde supersonic plane was. It is a supersonic jet capable of reaching Mach 2.2 (2,355 km/h) and carrying 55 passengers on flights of up to 8,000 km. A scaled-down prototype of the aircraft will be tested. The manufacturers guarantee that they will solve the problems that accompanied the Concorde's career, such as the extremely high fuel consumption and the "sonic boom" effect, the uncomfortable sonic boom generated by the passage of a plane at supersonic speed. There will be an end to four-engine planes which, in the not too distant past, were synonymous with safety and great capacity. Nowadays, these eternal machines in the form of the giant Boeing 747 and Airbus A380 are falling into disuse in passenger transport. They are too expensive to operate, require more maintenance and consume enormous amounts of fuel. The alternative to these four-engine behemoths are new state-of-the-art twin-engine wide bodies like the Airbus A350 and Boeing 787. Boeing is working on the new 777X, the largest twin-engine plane ever. Smaller jets, previously restricted to domestic flights, will be able to carry out international trips between continents.

Researchers at the Technical University of Delft, in the Netherlands, managed to accomplish for the first time the flight of a prototype of the new Flying-V commercial aircraft, which is touted as a new aircraft that could change aviation in the future [22]. With a V-shape that is quite different from traditional commercial aircraft, the Flying-V has a design designed to have more efficient fuel consumption. The main difference is that the passenger cabin, cargo compartment and fuel tanks are located on the plane's wings. The turbines, in turn, are located above the wings, located in a more central part of the aircraft than usual and close to the center of gravity. Computer models estimated that the changes in format allow fuel consumption to be 20% lower than that of the most advanced planes on the market. Aircraft manufacturer Airbus is also a partner in the project. It may still be years or decades before a full-size aircraft is complete, but testing the first prototype was an important step in the development of the new aircraft. The project envisages a plane with capacity for 314 passengers. Airbus presents designs for hydrogen-powered aircraft to avoid greenhouse gas emissions by 2035. It is a 'V'-shaped model, with wings integrated into the body of the plane. According to the company, the wide fuselage opens up several options for hydrogen storage and distribution, as well as for the cabin layout [23-25]. Two of the aircraft follow a design similar to combustion engine aircraft, but one of the designs is more revolutionary and shows what the aircraft of the future could be. It is a 'V' shaped model, with wings integrated into the body of the plane. According to the company, the wide fuselage opens up several options for hydrogen storage and distribution, as well as for the cabin layout [26].

Since the beginning of the 1990s, commercial aviation began to develop technologies that made the plane increasingly automated, thus gradually reducing the importance of the pilot in operating the aircraft, aiming to reduce air accidents caused by human error. Commercial aircraft manufacturers continue to research ways to improve planes, making them safer, more efficient and quieter. At the same time, pilots, airspace controllers and mechanics have become increasingly better trained, and aircraft are increasingly inspected to avoid accidents caused by human or mechanical error. Despite the growing problems currently faced by aviation in general, it is believed that the 21st century will be a century of great advances for aviation. It is estimated that in the future the use of pilots will be reduced, being replaced by remote control with the use of computers. The search for more efficient ways of flying and transporting passengers through the skies, emitting fewer polluting gases (or even eliminating them) is the aviation industry's biggest challenge for the coming years. This change will require a technological reformulation of planes and passenger habits. Airlines Finn air, from Finland, and Wider, from Norway, recently announced plans to introduce electric passenger planes into their fleets by 2026. In Canada, where the use of small commercial planes is also well adopted, Harbour Air is testing seaplanes adapted with electric thrusters. In the not too distant past, the concept of the four-engine aircraft was synonymous with safety and great capacity. Nowadays, machines in the form of the giant Boeing 747 and Airbus A380 are falling out of favour in passenger transport. They are too expensive to operate, require more maintenance and consume enormous amounts of fuel. The alternative to these four-engine giants are the new state-of-the-art twin-engine wide bodies, such as the Airbus A350 and the Boeing 787. Advances in engine technologies and new aerodynamic solutions have contributed to significantly reducing fuel consumption of commercial planes, opening up the possibility of increasingly longer routes. Taking advantage of this evolution, smaller planes, previously restricted to domestic flights, embarked on international travel between continents. Boeing's 737 MAX series jets have good autonomy numbers. The use of small and less expensive planes compared to wide bodies opens a new niche in the international travel market by offering cheaper tickets [27].

Another great invention underway is the hybrid aircraft that is designed to take off and land vertically with tilt rotors. This type of aircraft is growing rapidly as designers and start-ups realize that this is the future of aircraft. Volt Aero, a French aviation start up, is developing a hybrid plane that could become a "Tesla" of the skies, popularizing the technology and making it available to more people. The aircraft was designed to have a flight autonomy of up to 3.5 hours, with a range of 1,287 km, flying up to 8 times a day with a total flight time of 10 hours. Built with composite materials, the aircraft will be offered in three versions: the Casio 330, with four seats and a hybrid propulsion system with a power of 330 kW, the Casio 480, with six seats and a hybrid propulsion with 480 kW. The third model is the Casio 600, with 10 seats and 600 kW hybrid propulsion. Its cruising speed is estimated at 370 km/h, and in all-electric mode the autonomy is 200 km [28]. The hybrid aircraft will use two engines with a continuous power of 45 kW. A third engine powered by biofuel and modified with the help of the Formula E Solution F team, moves the rear propeller and recharges the batteries of the electric motors. The electric hybrid propulsion system is reliable. The E-Fan project is the first fully electric plane with two engines to cross the English Channel in 2015. In addition, he worked for 10 years on the development of fuel cells at General Motors. VoltAero should have started deliveries of its new aircraft at the end of 2022, initially in the four-seat Casio 330 configuration.

Space Transport of the Future

Space transport is of great importance for humanity given the need to promote intergalactic travel by human beings to the farthest reaches of the Universe and even to parallel universes. This action is necessary due to the need for human beings to leave planet Earth and colonize other worlds in the solar system or outside it, and even access parallel universes, to avoid their extinction with the occurrence of possible catastrophic events such as the eruption of volcanoes that could lead to the extinction of life on Earth as has already occurred in the past, the cooling of the Earth's core with the compromise of the Earth's magnetic field that protects us from threats from space, the collision with planet Earth of asteroids, comets, planets of the solar system and orphan planets, the Earth being hit by the emission of gamma rays from supernova stars that could lead to the extinction of life on Earth as has already occurred in the past, the continued increase of distance of the Moon from Earth and its catastrophic consequences on the planet's climate , the death of the Sun, the collision between the Andromeda and Milky Way galaxies and the end of the Universe. The biggest human challenge is the production of rockets that are capable of reaching speeds close to the speed of light (300,000 km/s). With this level of speed, it would be possible to reach the Moon in 1.3 s, the Sun in 8min20s, Pluto in 5h21s and it would take 100 thousand years to go from end to end in our Milky Way galaxy, 163 thousand years to go to the galaxy closest and 93 billion years to cross the visible Universe. For this purpose, we would therefore need a spacecraft that travels at an absurdly high speed for humanity to reach the farthest reaches of the Universe-something close to the speed of light.

To reach Earth's orbit at a distance of 100 km above sea level, current rockets require tons of fuel and oxidants to ensure adequate propulsion to reach around 40,320 km/h to escape Earth's gravity. This large volume of fuel also demands a lot of space on the spacecraft [29]. The space rocket currently used is a machine that moves by expelling a flow of gas behind it at high speed. Its objective is to send objects (especially artificial satellites, space probes and rovers) and/or spacecraft and men into outer space at speeds exceeding 40,320 km/h to overcome the Earth's gravitational attraction and reach altitudes exceeding 100 km above sea level. A rocket consists of a structure, a reaction propulsion engine and a payload. The structure serves to house the fuel and oxidizer (oxidizer) tanks and the payload (crew, passengers and equipment). These rockets also need to carry an oxidizer to react with the fuel. This mixture of superheated gases is then expanded in a divergent tube, the Laval Tube, also known as the Bell Tube, to direct the expanding gas backwards, and thus propel the rocket forward [30-33]. Under current conditions, for every 2 kilograms of people and objects or payload, 130 kilograms of rocket are needed, which restricts the number of astronauts and material sent on each flight and exponentially increases the cost of missions. Most current rockets carry a payload of 1.5% of their total size. By payload we mean people and objects [34].

What will future space transportation look like? A new engine being developed by two North American engineers, however, presents an alternative to optimize the amount of oxidants transported by rockets and reduce the cost of launches. This is the Fernis air aspiration propulsion system, a technology that combines characteristics of a conventional rocket engine and a jet engine. The Fernis passively draws in air from one end and then compresses it and combines it with kerosene and some oxygen gas in a combustion chamber. When complete, the system could reduce the amount of oxidants carried by a rocket by up to 20%. In theory, this means that rockets equipped with this technology could be more compact or allocate more compartment space to payloads such as people and equipment. The European Space Agency (ESA) decided to invest in a technology that has been dreamed of since the beginning of space exploration, that is, having a spacecraft capable of taking off from an airport, like a common plane, becoming a traditional rocket like this that surpasses the limits of the densest atmosphere and enters orbit and returns to the ground on the same runway from which it took off. The company Reaction Engines, hired to develop the first parts of the revolutionary engine that will equip this spacecraft of the future, claims that it is a reusable spacecraft, capable of taking off from a conventional airport, placing a 20-ton payload into orbit and returning to the ground at same runway from which it took off. This technology could become a reality in less than a decade. Another alternative is to use jet planes to transport conventional rockets several kilometres into the atmosphere and then release the vehicles, which complete the final stage of the journey into space on their own. Designed by NASA, the X-43 aircraft features a rocket engine to provide initial thrust for the vehicle. A revolutionary engine that can advance astronautically technology is the Scramjet engine, which is capable of reaching hypersonic speeds of up to 15 times the speed of sound. NASA successfully tested an engine of this type in 2004.

Another idea is to build a sail-shaped rocket that would be accelerated by the solar wind, allowing it to reach greater speed and travel longer distances. The concept spacecraft was named Skylon, and the hybrid engine that will equip it is called Saber, which is an unprecedented hybrid engine capable of "breathing" air while in the atmosphere, like a jet engine, becoming a rocket when reaches space [35-37]. Another possibility for advancement in rocket engine technology is the use of nuclear propulsion, in which a nuclear reactor heats a gas, producing a jet that is used to produce thrust. There are other types of rocket engines, such as thermal nuclear engines, which superheat a gas to high temperatures, using the heat generated by nuclear reactions, especially through the process of nuclear fission, where nuclear fuel is bombarded with neutrons, leading to the fission of the nucleus of atoms. This gas is then expanded in the Laval Tube, just like in chemical rockets. This type of rocket was developed and tested in the United States during the 1960s, but was never used. The gases expelled by this type of rocket can be radioactive, which makes it inadvisable to use them inside the Earth's atmosphere, but they can be used outside it. This type of rocket has the advantage of allowing much higher efficiencies than conventional chemical rockets, as they allow exhaust gases to be accelerated to much higher speeds. Currently, it is Russia that stands out in the development of thermal nuclear engines.

Humanity's greatest scientific and technological challenge is represented by the need to undertake space and interstellar travel. For this purpose, we would need a spacecraft that travels at an absurdly high speed - something close to the speed of light (300,000 km/s). In addition to not having rocket technology that develops speeds close to that of light, interstellar travel would be unfeasible for human beings even if we had these rockets because with speeds close to that of light there would be negative consequences for the lives of crew and passengers and for the spacecraft. For human beings to carry out long-distance space missions, it is necessary to find more advanced forms of rocket propulsion to reach distances of hundreds or thousands of light years, given that, according to scientists, current chemical rockets are limited by the maximum speed of rockets exhaust gases. Other alternatives proposed by scientists would consist of using nuclear thermal propulsion, a solar/ion engine as a new form of rocket propulsion, as well as the creation of a fusion reactor in which a rocket extracts hydrogen from interstellar space and liquefies it. NASA wants to test nuclear-powered rockets by 2027. Advanced nuclear thermal propulsion technology will allow the spacecraft to be faster, have shorter travel times and will also enable more agile cargo delivery to a new lunar base and robotic missions even further away. With the help of this technology, astronauts will be able to travel to and from deep space faster than ever before. The new propulsion has the potential to enable manned missions to Mars. According to NASA, a nuclear-powered thermal rocket can be three to four times more efficient than conventional rockets and reduce travel time to the red planet, that is, from 8 months to 2 months. Ion engine took a ship to the edge of the Solar System. The probe is the first space exploration mission to use an ion engine instead of conventional thrusters, powered by chemical reactions. The ion propulsion system will be adopted in the next generation of NASA spacecraft. The propellant uses electrical energy to create magnetically charged fuel particles, usually in the form of xenon gas, accelerating these particles to very high speeds. Whether it is energy from the Sun or the atom, it would be used to ionize (or positively charge) an inert gas such as xenon or krypton. The accelerated ions would be pushed out of the thruster, propelling the ship forward. If at first the spacecraft would advance slowly, over time the acceleration would be gradual and inexorable, reaching a speed close to that of light, enabling a human being to reach nearby stars, such as Alpha Centauri, 4.3 light years away.

Buzzard propulsion is another propulsion method for spacecraft that could accelerate to a speed close to the speed of light, and would be a very efficient type of spacecraft. The most obvious fuel source, which was proposed by buzzard, is hydrogen fusion, as hydrogen is believed to be the most common component of interstellar gas. An electromagnetic field could attract positive ions from the interstellar medium and force them into the ramjet engine. Superfast space travel close to the speed of light would, however, be fatal to humans, according to a publication by Edelstein and Edelstein in Natural Science which reports that the hydrogen in any aircraft capable of traveling at the speed of light would also prevent it from making the trip to this speed because, as the ship's speed approached that of light, the interstellar H hydrogen would transform into intense radiation that would quickly kill the passengers and destroy the electronic instruments. Furthermore, the loss of energy from ionizing radiation passing through the outside of the ship would represent an increasing increase in heat that would require large energy dumps to cool the ship. Even if it were possible to create a ship capable of traveling at speeds close to that of light, it would not be able to transport people. There is a natural speed limit imposed by safe levels of radiation due to hydrogen that means that humans cannot travel at more than half the speed of light unless they want a quick, immediate death.

The theory of general relativity imposes severe restrictions on interstellar travel. One of them is the most obvious: nothing can be accelerated to speeds above that of light, which is about 300,000 km/s. Even if we could travel at that speed, it would still take a long time to reach other stars and their respective planetary systems. The theory of general relativity opened up new fields of science and allowed ideas such as creating a warp drive to travel to any corner of the Universe. The concept of warp space is not new. It is a type of engine that allows the spacecraft to travel at speeds faster than the speed of light. It is a technology that would allow the creation of a "bubble" in space-time. This bubble could create a kind of bridge between two points in space. Travel to destinations located light years away from Earth will still remain beyond our reach, but space warp technology, if it ever exists, could be the solution to interstellar travel.

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