Capgemini

THE FUTURE
OF AVIATION

DELIVERING A GREENER TOMORROW

EMPLOYING A GLOBAL APPROACH TO AIR MOBILITY AND SUSTAINABILITY

Air transportation will be shaped by the expansion of urban populations

By 2050, the world's population is predicted to reach 9.7 billion[1] with 70% of people living in cities.[2] This will lead to further challenges for road and rail transport, such as increased congestion, longer travel times, and greater maintenance requirements. Aviation is set to play a vital role in tackling these transport issues on the ground.

The future of aeronautics will be defined by two key axes that are inextricably linked: new aerial mobility and sustainability. Short-distance flights in urban aircraft are set to revolutionize travel, and, at a time when airlines have pledged to achieve net- zero CO_2 emissions by 2050,[3] the next generation of aerial vehicles must be developed with sustainability at its core.

Applying a global strategy to these drivers is the most effective way to find solutions that can be applied around the world. This means addressing issues holistically in collaboration with experts and stakeholders internationally.

What are eVTOL vehicles?
eVTOL (Electric Vertical Take-Off and Landing) vehicles are lightweight commercial aircraft, operated by either a pilot or – in the future – an autonomous system. These vehicles are designed for lower altitudes and shorter ranges than conventional commercial aircraft and can take off and land in a vertical fashion, like helicopters. However, unlike helicopters, eVTOL vehicles have lower operating costs, greater efficiency, and superior maneuverability. And, instead of being powered by conventional fuel sources, they use battery-based propulsion or hybrid systems.

The number of eVTOL vehicles, including electric aircraft and drones, is expected to grow significantly in the coming years. In so-called megacities like New York, Shanghai, and Tokyo, the development of air taxis and air ambulances is already underway to bypass difficult traffic conditions. The urban air mobility (UAM) market is expected to increase momentum from 2030 onwards, with the addressable UAM market being worth around $9 trillion by 2050.[4]

The use of eVTOL vehicles for commercial deliveries is also set to grow exponentially. The world's first commercial drone delivery was completed by Domino's Pizza in 2016. By 2026, more than one million drones are expected to be carrying out retail deliveries.[5] Major players in the delivery and logistics industries – including UPS, FedEx, DHL, and Amazon – have also been investing in eVTOL technology for years.

Aside from the logistical issues caused by increased road traffic, there are also environmental issues and air quality concerns to consider. Road travel currently accounts for 15% of the total global CO_2 emissions,[6] whereas commercial aviation is responsible for around 2.5%.[7]

Aerial vehicles are being considered as greener alternatives to internal combustion engine (ICE) road vehicles. Ground vehicles are currently responsible for 29% of all greenhouse gas emissions in the USA, but drones powered by an electric motor and lithium-ion batteries will produce far fewer greenhouse gases throughout their lifetime than fossil fuel-powered road vehicles.

[1] UNFPA, Population Data Portal

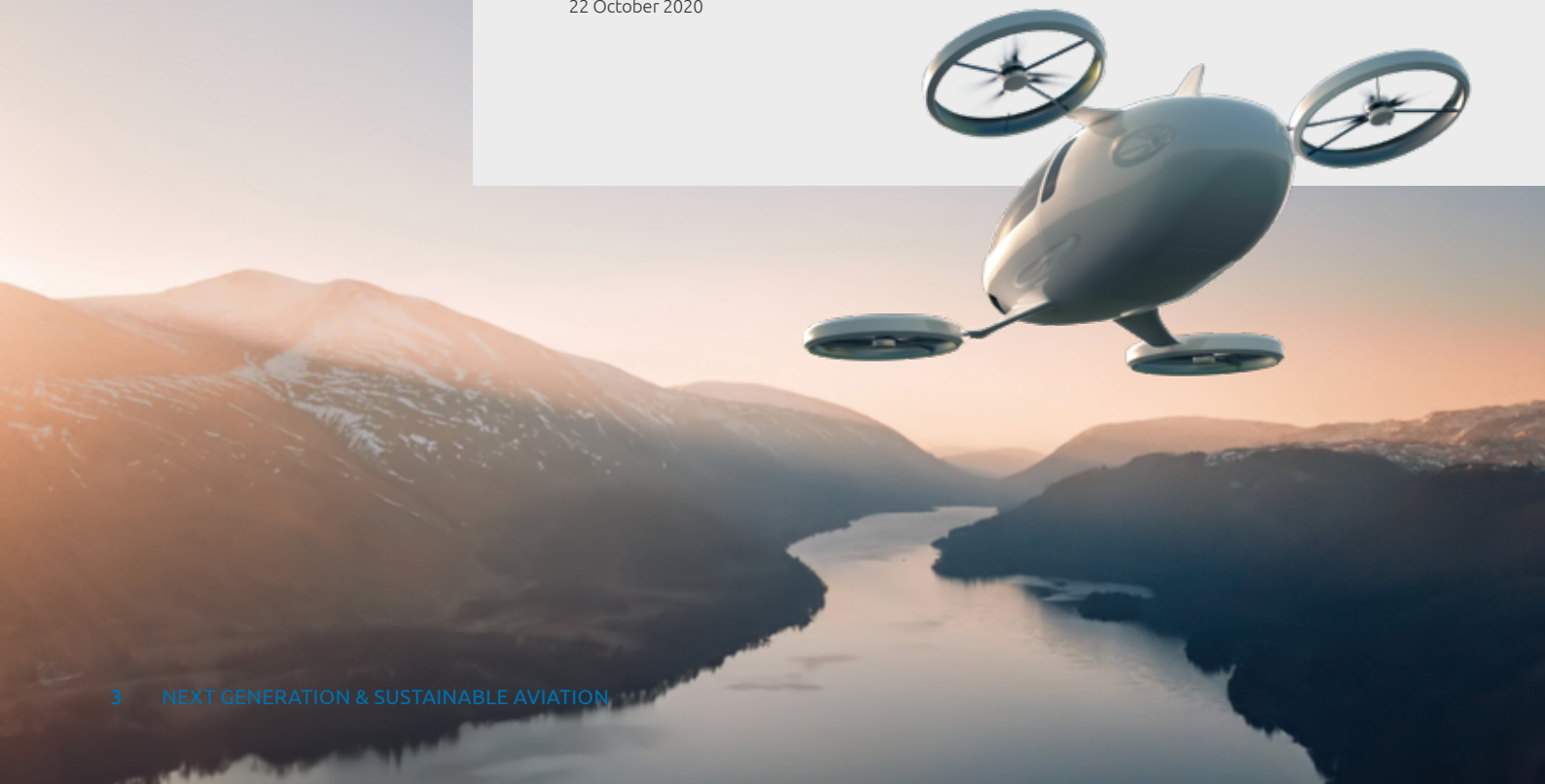
[2] The World Bank, Urban Development, 6 October 2022

[3] IATA, Our Commitment to Fly Net Zero by 2050 [4] eVTOL/Urban Air Mobility TAM Update: A Slow Take-Off, But Sky's the Limit, Morgan Stanley, 6 May 2021

[5] Why Flying Drones Could Disrupt Mobility and Transportation Beyond COVID-19, Gartner, 19 May 2020

[6] Our World in Data, Cars, planes, trains: where do CO2 emissions from transport come from? 6 October 2020

[7] Our World in Data, Climate change and flying: what share of global CO2 emissions come from aviation? 22 October 2020



WHY A GLOBAL APPROACH IS IMPORTANT

Effectively launching new aerial vehicles into the market requires a global effort. A collaborative network of companies and specialists from around the world is necessary. This would include leading experts from various industries including aerospace, automotive, and telecommunications.

Aerospace companies have significant expertise in aeronautical design, air traffic management systems, and air safety standards. They also have well-established relationships with the regulatory agencies responsible for approving eVTOLs for commercial operations.

Automotive manufacturers bring valuable experience to the table when it comes to producing power sources for vehicles with a low environmental impact, like lithium-ion batteries. They also have expertise in high-volume vehicle production and supply chain management. This is important for ensuring that the operating costs of eVTOLs align more closely with the automotive model, rather than the model currently used in aerospace.

Communications service providers are indispensable partners because of the need for 5G technology for eVTOLs. 5G technology ensures the network reliability, low latency, and high bandwidth that are needed to manage flight paths and communicate with other air traffic safely and cost-effectively.

Leveraging the knowledge and experience of strategic partners is the best way to develop new aerial mobility in a way that prioritizes sustainability. Using insights from these partnerships can also mitigate potential risks in development and reduce delivery times.

CLOUD-BASED ENGINEERING FACILITATES DIGITAL CONTINUITY

Collaborative engineering design – including international engineering teams – can be accomplished by integrating digital product design tools, including model-based systems engineering (MBSE) and product lifecycle management (PLM) systems, within the cloud.

Engineers from across the world can view and work on the entire system seamlessly in one continuous flow. This approach allows for whole system-level simulations where designers can experiment virtually and gain insights into the impact on design, supply chains, and in-use emissions. This speeds up the whole design process as rapid iterations of designs can be achieved by collecting and sharing global test data.

By consolidating computing resources in cloud-based data centers, cloud providers can achieve economies of scale and pass the financial benefits on to their clients. From a sustainability perspective, cloud-based data centers can significantly reduce energy consumption per unit of computing power, which results in lower greenhouse gas emissions and energy costs compared to traditional on-site data centers.

Additionally, cloud-based engineering enhances collaboration across national and international teams, reducing the need for travel, which leads to lower carbon emissions and other environmental impacts.

CHOOSING THE IDEAL SOFTWARE TOOLS FOR AVIATION PROJECTS

By selecting and deploying the right software tools for product lifecycle management and design, aviation developers can build cloud-based engineering systems for net zero objectives that are up to ten times faster than current industry standards.

However, there are no one-size-fits-all solutions. Working with experienced partner organizations helps aviation developers carefully choose software tools from the wide range of options available. This is done based on the project's specific requirements and by considering how different tools integrate with one another.

Once the tools have been chosen, the implementation of the software necessitates end-to-end modifications to IT architecture, data management, and integration with cloud providers. There is also the need for customization and plugins throughout the entire system, in accordance with the organization's engineering standards, lifecycle methodologies, and innovation plans, to ensure continuity.

ACHIEVING SUSTAINABLE PROPULSION FOR AIRCRAFT

When it comes to carbon emissions, aviation is a heavily scrutinized sector, and the industry's decarbonization efforts are being keenly observed. To achieve net zero goals, organizations must design aircraft with intelligent capabilities to achieve lower fuel consumption.

Increasingly, fuels will be adopted based on their sustainability credentials. New air mobility aircraft will use different energy sources, including fully electric vehicles, alongside hybrid models. Aircraft manufacturers have long been exploring the possibilities of green electro-fuel and sustainable aviation fuels (SAFs).

Green electro-fuel, also known as green synthetic fuel, is produced using decarbonized methods. Renewable energy sources are used to produce hydrogen and capture carbon either from the atmosphere or industrial facilities, creating a sustainable fuel option.

SAFs – made from organic materials and non-fossil sources, such as kitchen oil, rather than kerosene – are being looked at as a viable fuel option, while hydrogen is also being considered as a long-term solution for medium-range or long-range aircraft. However, there are still significant technological and economic hurdles to overcome. The production and supply of hydrogen and SAFs for the market poses challenges, and scaling up both solutions will be a key obstacle. If hydrogen or SAFs become widespread fuels for aircraft, entire ecosystems will need to be supported and safety concerns will need to be addressed – especially related to their use within airports. To promote the advancement of aircraft using hydrogen and SAFs, regulators in Europe and the USA are offering incentives for both sectors.

THE INDUSTRY IS ACCELERATING AND THE TIME FOR ACTION IS NOW

Social pressure surrounding climate change – and the rise of so-called "flight- shaming" – has led to 27% of people to consider reducing their air travel.[8] It is also making it harder for aerospace companies to recruit and retain talent.

Despite sustainability concerns, demand for air travel is set to rise. It has been forecast that the number of passengers traveling by air will climb from 4.5 billion in 2019[9] to over 10 billion by 2050.[10] As the aviation industry stands now, flights carrying 10 billion air passengers would generate around 2,000 megatonnes of CO_2.[10] To achieve its goal of net zero carbon emissions by 2050, the global air transport industry must take significant steps to make its technology, fuels, and operations more sustainable. Although sustainability objectives should aim to go beyond carbon emissions alone, the non-CO_2 effects of aviation account for two-thirds of its total climate impact and this also needs to be addressed.[11]

[8] Reuters, Flight shaming hits air travel as 'Greta effect' takes off, 2 October 2019

[9] ICAO, Annual Report 2019, The World of Air Travel in 2019

[10] Waypoint 2050, Air Transport Action Group, Second edition: September 2021

[11] Transport & Aviation, Non-CO2 effects of aviation

Achieving greener air travel and decarbonizing aviation requires a strong ecosystem along the value chain. This includes aircraft manufacturers, energy providers, and a full supporting infrastructure. Sustainable aviation fuel does not require the aircraft to be modified too much. However, there is a greater concern about the biological or chemical processes required to generate SAF or hydrogen at the volumes that are needed – and in a more sustainable way. Sufficiently mature technology must be embedded in the process to generate the required volumes.

Sustainability itself is a time-sensitive issue and neglecting this matter today will result in compounding challenges that will escalate over time. Engineering speed should be prioritized when redesigning airframes, wings, and engines. Additionally, accelerating the whole development process and launching an innovative product ahead of your competitors can offer a competitive edge – and a chance to earn billions of dollars in revenue.

EVERYONE SAID IT WAS IMPOSSIBLE

"Solar Impulse 2" – solar-powered airplane

For the team who embarked on the first-ever round-the-world solar flight, an early obstacle was finding the right partners to make it happen. There was resistance within the aviation industry from people who thought the project would never get off the ground. The challenges of the undertaking were clear from the beginning: the airframe needed to be extremely light while also large enough to accommodate the solar panels required to power its propellers. The lightness of the airplane also meant that the aircraft would be particularly vulnerable to weather conditions. Despite these challenges – and after 13 years of development – the dream of a round-the-world solar flight was finally accomplished in 2016.

Capgemini took on the challenge and provided support in three critical areas:

Flight strategy
Capgemini was responsible for establishing flight path patterns and the routing of the airplane. Our engineers, based in the mission control center, were also in charge of the advanced flight simulation.

Virtual copilot system
The virtual copilot system, which detects inconsistencies in the airplane's behavior, was created and maintained by our engineers.

Safety and security analysis
To obtain flight permits and other certifications from the appropriate authorities, we had to first ensure and improve the reliability of the airplane.

A PARTNER FOR NEXT-GENERATION AND SUSTAINABLE AVIATION

Capgemini is a recognized leader in sustainability enablement technology services.[12] We have established strong partnerships with solution providers and manufacturers worldwide, bringing together over three decades of experience in the aeronautics industry and partner knowledge from a range of sectors, including energy, automotive, and telecommunications. This cross-sector experience is invaluable. For example, expertise from the development of autonomous driving can be transferred to the development of autonomous aviation systems and single-pilot projects.

Capgemini provides a streamlined approach to aviation engineering by acting as a single strategic partner to our clients, eliminating the need to coordinate multiple partners and reducing costs.

Working with leading innovators around the world to test and deploy sustainable technologies, our global approach allows us to provide cohesive and effective solutions for aviation technology engineering.

[12] Everest Group, Sustainability Enablement Technology Services PEAK Matrix® Assessment 2022, June 2022

About Capgemini

Capgemini is a global leader in partnering with companies to transform and manage their business by harnessing the power of technology. The Group is guided every day by its purpose of unleashing human energy through technology for an inclusive and sustainable future. It is a responsible and diverse organization of over 360,000 team members in more than 50 countries. With its strong 55-year heritage and deep industry expertise, Capgemini is trusted by its clients to address the entire breadth of their business needs, from strategy and design to operations, fueled by the fast evolving and innovative world of cloud, data, AI, connectivity, software, digital engineering, and platforms. The Group reported 2022 global revenues of €22 billion.

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