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Sustainability of the Aviation Industry

(Presented by JAA Training Organisation)

A submission by the JAA Training Organisation (JAA TO) upon invitation of Hermes - Air Transport Organisation's call for position papers on ***Sustainability of the Aviation Industry****.*

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Introduction

Commercial aviation has seen significant advancements in sustainability since the late 1950´s: aeroplane design, flight speed and travel times, safety standards, traveller capacity, performance optimisations and fuel efficiency, industry innovation and environmental impact. Most of these improvements were made possible due to technological (r)evolutions, seeking to alter the environmental footprint. Next to industry innovations, legislation trying to implement new standards and regulations, incentivise the air transport community to reach common sustainability goals. Aviation's highest bodies, international manufacturers, trade associations, airport councils and community initiatives call for further improvements and solutions making air transport more efficient, sustainable and innovative. The global reach and omnipresence of aviation has potential to blueprint other sustainability efforts in connected sectors and markets.

Established in 1983, the Committee on Aviation Environmental Protection (CAEP) assists the International Civil Aviation Organization (ICAO) Council regarding aviation environmental impact and has since advanced various agendas by formulating new policies and promoting the adoption of new Standards and Recommended Practices (e.g. Air Transport Action Group (ATAG) Commitment to Action on Climate Change 2008, ICAO CAEP/ et seqq.). In equally ambitious terms, the International Air Transport Association (IATA) FlyNetZero2050 resolution advocates for the progressive reduction in emissions while accommodating the restarting and growing flight demand. Along those lines, sustainable blueprints for a green recovery are necessary (e.g. ATAG Waypoint 2050). After hesitant adoption, the civil air transport industry started to agree on the general need to reduce CO2 emissions and improve overall sustainability factors. This evolving industry commitment defines goals for the short-, medium- and long-term taking into account strategic operations, economic feasibility, infrastructure demands, global market dynamics and technology trends

The next decades will see more technological innovations which should enable industry stakeholders to transform operations, aircraft configurations and parts of the global aviation supply chain into more sustainable alternatives that help to reduce the environmental footprint. Due to the interconnectedness of the air transport system, safety-, environmental-, economic- and operational challenges remain. The following essay explores industry best practices and solutions that can path the way to a sustainable aviation future.

International framework landscape

To reap the full innovative potential, interorganisational initiatives and supranational, collaborative agreements need to further provide the necessary regulatory framework which fosters and accelerates economic, ecologic and societal sustainability in the aviation value chain. To this point, regulatory framework incentives have been provisioned along three types of operations:

- Air Traffic Management Operations (flight sectors and traffic flow activities)

- Airport Operations (ground-based system and ground movement management)

- Air Operations (flight and aircraft maintenance)

ATM Operations

In 1999, the European Union (EU) launched a pan-European air transport initiative with the objective to reform the Air Traffic Management (ATM) and Air Navigation Services (ANS) to better deal with continued air traffic growth – the Single European Sky (SES). Seeking to move European aviation to operations in a safe, cost efficient and environmentally friendly way, the SES (additionally the Single European Sky ATM Research (SESAR) and the Free Route Airspace) features pragmatic legislative approaches to improve the airspace capacity and efficiency in ATM and ANS to better design, plan, manage and reduce the fragmentation of European airspace between Member States and technologies. The benefits of the SES could potentially be huge; tripling the airspace capacity, reduce ATM cost by 50%, improve safety tenfold and reduce environmental impact by 10%. Joint programmes like SESAR manage the technological and industrial dimensions of the SES aiming to improve ATM performance by modernizing and harmonizing systems through innovative technology and operational optimization. SESAR's development costs remain high estimated to be around EUR 3.7 billion which slow down progress and adoption. Next to financing, current implementation efforts are stalling in the reticence of stakeholders' regarding scopes of responsibility, performance based targets and needed regulatory updates or agenda-setting (e.g. European Green Deal).

Airport Operations

The industry-wide initiative NetZero2050 with commitment of ACI Europe illustrates the airport industry's ambitions and call to Members for reducing carbon emission and ultimately become carbon neutral. 235 airports across Europe committed to Net Zero by 2050 at the latest and more than 90 airports are set to achieve Net Zero by 2030. Additionally, 338 airports committed to the Airport Carbon Accreditation (ACA) programme further devote their efforts into reducing energy and fuel consumption through the design of new energy-efficient infrastructure, investing in low energy vehicles and equipment and switching to zero-carbon energy and fuel sources. While the ambitions in the ACA programme are high, large discrepancies in resources and facility equipment exist. Uneven access and distribution in the deployment of Sustainable Aviation Fuels (SAF) or charging infrastructure for electrified aircraft operations is and will become a challenge. In spite of all the efforts made by ACI, domestic politics and policy will continue to exert influence on airport infrastructure. On another note, Airport Collaborative Decision Making (ACDM) aims at improving the overall efficiency of airport operations by optimizing the use of resources and improving the predictability of air traffic. It has economic capacity, safety, and environmental benefits.

In pursuit of the technological progress towards greater sustainability, the aeronautical industry has made hide large investments. Mainly, the National Aeronautics and Space Administration (NASA) and US Federal Aviation Administration (FAA) cultivated a competitive environment in which commercial aviation companies implement and advance technology concepts that are based on those initial state-funded R&D programs, like CLEEN (Continuous Lower Energy, Emissions and Noise), AST (Advance Subsonic Technology), UEET (Ultra-Efficient Engine Technology), ERA (Environmentally Responsible Aviation) and Clean Sky One and Two. The resource-rich US approach created a unique competitive enterprise landscape that incentivises and awards private investments and pioneer R&D engineering for the advancement of the civil air transport sector. EU and pan- European initiatives seek to close the gap in its own fragmented markets.

The road to aviation sustainability inevitably incorporates reducing the impact on climate change by minimising greenhouse emissions. In achievement of all related objectives, the aviation industry must reduce the amount of fuel burn, produce efficient, aerodynamic aircraft designs and gradually adopt evolutionary aircraft technologies that can be incorporated into the green configurations, retrofits, serial upgrades and newly designed components and systems. Some of these industry practices include:

- **Manufacturer design concepts** that use innovative materials and technology for sustainable airplane manufacturing, maintenance and operations. These processes and R&D includes strut-braced wings architecture, blended wing bodies, double-bubble and Parsifal box-wing aircrafts. Improvements in structure and materials, like additive 3D manufacturing and (recyclable) composites advance material use in engines and can contribute to the circular economy. New design information allows for quicker and more flexible production, reduces material waste compared to traditional approaches and it also results in much lighter parts reducing aircraft weight and fuel use. 3D printed parts are already flying on the Airbus A320 Neo and A350. Composite materials have been used in aerospace for decades, 50% of the Boeing B787 and 53% of Airbus A350 are made of composite material.

- **Aerodynamic technology** has progressed continuously throughout the past decades to achieve reduction of fuel consumption, and therefore CO2 emissions, by the reduction of aerodynamic drag, intervention of propulsion and multi-disciplinary optimization. These aerodynamic technologies concern new aircraft configurations, aerodynamic process tools and capabilities, and aerodynamic products. Advances in aerodynamic tools, capabilities and processes such Computational Fluid Dynamics (CFD) and wing tunnel testing, mark today's standard for the development and evaluation of new aerodynamic technologies. New aircraft configurations such as more integrated wing engines, pilot configurations, and the integration of new propulsion system have increased the aerodynamic efficiency even further. R&D in materials science and engineering technology produce ever new material structures and aerodynamic products that can for example increase the effective wingspan or maximize effective span extension due to composite materials.

- **Fuel efficiency** considerations use configurations that change the engine air flow and thus the pressure and temperature. New turbofan technology has been moving towards improving the propulsive efficiency with higher engine bypass ratio (BPR) and lower fan pressure ratios (FPR).

These widely used higher BPR and lower FPR designs generate more thrust and support an airplane's fuel optimisation.

- **CO2 emission** is directly proportional to fuel burn and therefore any reduction efforts demand focusing on improving weight and engine size which can influence the engine specific fuel consumption. There are three fundamental technology paths to reduce the fuel consumption of propulsion systems: increased thermal efficiency (by reducing component losses or by increasing the overall compressor pressure ratio), increased property efficiency (by increasing the engine bypass ratio PVR), and minimised engine weight and drag.

- **Thermal efficiency** is largely determined by the overall pressure ratio (OPR), the turbine inlet temperature (TIT), and the performances of the individual component compressor turbines and combustion chambers. With increasing OPR performance the TIT also rises. This average increase in TIT has been around 19°K/year, which is substantially higher than the increase in operating metal temperature of around 5°K/year. To avoid performance penalties, innovative cooling techniques, aerodynamic component designs, higher strength and higher temperature materials and improve computational analysis techniques are in development.

- **Aircraft noise** limits and reduction is addressed through ICAO initiatives and remains a main priority globally in order to achieve key environmental goals. Millions of people in residential/urban communities are exposed to aircraft noise making the call for global standards for aircraft noise certifications and international and local regulatory framework so important. Despite new aircraft engines, air frame design technology and noise reduction schemes, international regulations like the ICAO Annex 16 Vol. 1 of the Chicago Convention on Balanced Approach to Aircraft Noise Management (noise at source) have undergone several changes in the Standards and Recommended Practices (SARPs) to reflect technological and societal standards.

Green Future

Aviation industry's commitment to align with the Paris Agreement goal for global warming not to exceed 1.5°C produces great challenges for legislative and industry stakeholders alike. Benchmarks and innovations will be necessary to achieve the ambitious milestones, and air transport partners are required to cooperate short-, medium- and long-term on the optimisation of the entire aviation value chain for a sustainable aviation future. In ambition of the goal NetZero2050, radically new aircraft configurations and operations will be required to significantly reduce noise, fuel consumption and consequently CO2 emissions. Airlines, airports and manufacturers and governing bodies need to cooperate on the continuous advancement of green solutions.

Mitigation and management of noise in aviation follows along the domains of technology, operational improvements, land use planning, noise communication and community engagement. Airports should participate actively in contributing to local planning policy to ensure sustainable land development and infrastructure schemes that consider acoustic insulation, land/property acquisition, wildlife management and other environmental factors. Going beyond the one-size-fitsall approach, information and communication campaigns to local communities allow for informed discourse about statistical noise values, aircraft noise certification and runway direction as well as grounding orders during sensitive times. ICAO Annex 16 aims to ensure that noise reductions offered by technology are reflected in reductions around airports.

Minimising CO2 emission is the second main objective (including nitrogenous emission and contrails). Currently, propulsion improvements (such as engine with high bypass ratio), aerodynamic improvements (such as laminar flow control systems and high-level devices) new structure and materials (lighter with better performances), and improvements in operations procedure supported an increasing efficiency of 1.5% per year between 2009 and 2020. The use of evolutionary technologies is the prime enabler to reach the next medium-term goals on aviation sustainability.

In the near future, significant technological contributions can be expected realising new disruptive designs, such as the hybrid wing body with layer ingestion, open rotor hybrid engines and aircrafts with hydrogen propulsion, hydrogen batteries and sustainable synthetic fuels (SAFs). The long-term commitment to action on climate change sets ambitious goals for civil aviation. For green, sustainable aviation future the involvement and effort of the entire air transport sector, manufacturers, airlines, airports, air navigation service providers, government and agencies is required. Aviation sustainability is the green deal for our future.

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