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AI In Improving Fuel Efficiency and Reducing Emissions in The Aerospace Industry

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Abstract

The aerospace industry is facing one of its greatest challenges to date. If the industry is to have any hope of reaching its ambitious target of net-zero carbon dioxide emissions by 2050, it is going to need many technological advancements to line up. One of the most immediate actions this industry can take to reduce its carbon footprint is increasing the efficiency of fuel consumption by its aerospace systems. AI technology has been employed to help with this tiring task. This paper aims to analyze the implications of Artificial Intelligence in promoting fuel efficiency in the aerospace industry and the challenges that come along with the initiative.

Keywords: net-zero, carbon footprint, Artificial Intelligence, fuel efficiency, initiative

The global climate crisis has gained immense prominence in recent years due to abrupt changes in temperatures worldwide. Certain climatic transformations, including but not limited to water scarcity, melting polar ice caps, severe fires, and declining biodiversity, have made various industries stop and reevaluate their contributions to carbon footprints. The aerospace industry in particular has attempted to decrease its contribution by examining the fuel efficiency of its present and upcoming systems. In this industry, artificial intelligence is used for back-end business operations such as operations, marketing, finance, and human resources, as well as for the design, development, testing, and optimisation of aircraft, as well as for pre- and post-flight inspection and safety compliance (Collimator, 2023)[3]. Besides this, AI plays a vital role in the effort to lower carbon emissions.

From 1990 to 2018, U.S. carbon dioxide emissions from domestic commercial flights grew 18 by percent and were foreseen to rise further in the next 20 years. In addition, from 1990 to 2010, global aircraft carbon dioxide emissions soared by nearly 40 percent. From 2013 to 2018, global emissions grew by an additional 26 percent. If global aviation were a country, it would rank as the 20th largest carbon dioxide emitter. At this rate, in the absence of new policies, global aircraft emissions are projected to triple by 2050, contravening our goal of net-zero carbon dioxide emissions by 2050. Moreover, within the United States, airplanes remain the single largest producer of carbon dioxide emissions in the transportation sector that is not yet subject to federal greenhouse gas regulations (Center for Climate and Energy Solutions, 2020)[2]. “More and more people were talking about global warming, and there was an increased awareness of young people regarding a lot of practice of the airline industry. And I think that’s when we had a focus change in the airlines because that’s where they realized that there was a strategic risk for them and that they would lose customers if they did not align with the future of society”, says Feray[7].

The French firm Safety Line discovered that optimizing fuel during the climb phase can result in appreciable fuel savings, considering an aircraft consumes fuel at its highest rate during this phase. They developed a machine learning tool that allows pilots to optimize climb profiles before each flight. This way, they anticipate saving up to 6 percent of fuel during each climb phase. Another approach is to utilize AI-powered systems to produce lightweight aircraft components (Autonomous Manufacturing, 2018) [1]. Generative design leverages AI to enable a paradigm shift in the design process based on specified criteria. It employs enormous amounts of computational power to conjure radical designs automatically, revolutionizing the way human designers work, enabling us to build products beyond our creative line (Douglas H., 2018)[4]. This way engineers can focus on the specifications of the product, which in this situation might include better aerodynamics, reduced weight, improved engine BSFC and propulsive efficiency, or TSFC, maximizing lift-to-drag ratio by minimizing parasitic drag and lift-generated induced drag (Georgina T., 2023), while AI creates unthinkable designs and brings it to life in unimaginable ways[5]. "Humans switch from being creators to curators" [4]. AI based flexible navigation systems intend to replace the current airplane navigation plan with real time updates. This way, aircraft can avoid unfavorable weather conditions such as storms, high winds, and take advantage of feasible weather conditions. Studies have documented that 1.4 tons of carbon dioxide are cut per flight by using this technology. A similar strategy includes Continuous Climb Operations and Continuous Descent Operations (CCO and CDO), which enable aircraft to follow an optimal, variable flight path that conveys major natural and financial advantages. Among them are a reduction in gasoline consumption, reduced greenhouse gas emissions, noise, and fuel expenses (Rajasimha K., 2018)[8]. Additionally, AI assists in harnessing and analyzing large volumes of data from multiple procedures, which in turn is used to reduce carbon footprints and boost global productivity.

Every new endeavor faces challenges, and this issue is no exception. Major advances in the performance of aerospace systems are getting increasingly harder to achieve. As a result, companies are reaching for immature technology to do the task. Despite these technologies not being ready for production, companies like The Boeing 787 and The Airbus A400M bundle multiple innovations into a single program, which makes execution on schedule and on budget less likely. The Boeing 787 included composite materials, an all-electric design, new propulsion, and a passenger-friendly cabin with increased pressure and humidity. The Airbus A400M featured new engines, more composite materials, and counter-rotating propellers (Greg M., et al., 2022)[6]. Yet another challenge is data management. Data, being the fuel of any AI program, drives the intelligence of computer algorithms. However, data privacy concerns exist alongside the need to manage airline consumer data responsibly. It is challenging yet crucial for companies to find ways to implement privacy and cybersecurity practices in the development of AI systems that handle personal data (Autonomous Manufacturing, 2018)[1].

However, as applications for AI in the aerospace industry continue to expand, more airlines are ready to adopt solutions powered by artificial intelligence and machine learning. While AI requires significant investment and still faces some barriers to wider adoption, this innovative technology offers enormous potential to optimize manufacturing processes, tackle malfunctions, and improve performance in various tasks. Previous studies have shown that as AI technology continues to evolve, it will become more accessible and reasonably priced for airlines of all sizes. AI being very much in its infancy, this will incentivize innovation and efficiency.

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