The role of the pilot in climate change mitigation through operations

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Introduction

Among the ICAO basket of measures, operational improvements play an important role in reducing the impact on the climate. Every contribution counts toward a net zero future aligned with the long-term aspirational goals. Equally important but often overlooked is the fact that without improvements in flight operations and air traffic management (ATM) infrastructure, the expanding aviation sector cannot be accommodated in the future. Flight and airspace efficiency will decrease rather than improve, leading to increased CO_2 emissions.

Safety Considerations in Operational Improvements

Safety is paramount, as underlined by all stakeholders within ICAO, and it must continue to improve as air traffic increases. For any operational improvement aimed at mitigating the environmental impact of aviation, assessing the potential effects on flight safety and on flight operations is a prerequisite. Before introducing any changes to flight operations at the airport or in the air , it is essential to consult with relevant stakeholders regarding the operational implications, potential benefits, and technical limitations of such changes.[1]

The flight crew may have the overall perspective and plays a role in deciding whether a new flight procedure, cockpit system, or airport design can safely be adopted and is practicable. Conversely, such changes may lack flexibility, robustness, clear instructions, harmonization, or reliability in operations and may increase workload for daily flight operations.

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Airline pilots are organized under national pilot associations and, internationally, under the International Federation of Airline Pilot Associations (IFALPA). While safety remains the primary concern of both the pilot and IFALPA, social and environmental sustainability is considered as a fundamental requirement for future growth. To emphasize this commitment, IFALPA has extended its mission "to contribute to the industry's efforts to minimize the environmental impact of commercial aviation." IFALPA believes that pilots can play a crucial role in bridging the gap between science and flight operations. Collaborative efforts are fundamental in any operational improvement initiative.

While IFALPA is committed to advancing environmental sustainability in aviation, the successful implementation of operational improvements requires addressing several critical challenges. The challenges for implementation of operational improvements, as identified by IFALPA, refer to:

- Impact on safety
- Effectiveness of measures
- Practicability of measures
- Economical reasonableness
- Airport Capacity and noise restrictions
- Health issues ground personnel
- Training / awareness issues for operational staff / pilots
- Increased traffic demand

For example, initiatives like contrail management and **Continuous Descent Operations (CDO)** require careful consideration of flight path adjustments and altitude management. **Contrail management**, aimed at reducing the climate impact of condensation trails, and CDO, which optimizes descent profiles for fuel efficiency, demand operational changes that can affect flight efficiency, fuel consumption, and air traffic flow. However, implementation of these measures cannot be effective without considering the operational issues and implications such as increased cockpit workload, required communication protocols and changes to cockpit procedures such as flight path management. These complexities underscore the need for real-world flight testing and close collaboration with the operational actors: the airline operator, the pilot and the air traffic controller. The scale of flight testing should be such to reflect actual flight operation in order to assess the impact on the whole (ATM) system.

Note. IFALPA holds a position as observer in ICAO CAEP for many years. Since 2021, a dedicated IFALPA climate working group of experienced airline pilots has combined operational expertise from the global pilot community to address the many environmental challenges and assist the work within ICAO/CAEP. Several position and information papers have been published to inform pilots and other stakeholders on the pilot's views.[2] [3]

Operational opportunities and the role of the pilot

Several flight techniques and flight management choices are available to the pilot in the daily flight operations to save fuel and optimize flight efficiency. ICAO has compiled these operational opportunities in the ICAO Doc 10013 Operational Opportunities to Reduce Fuel and Emissions. This Manual was developed in close collaboration with CAEP Members and Observers, including IFALPA, to provide meaningful, efficient, and safe options for the reduction of fuel use and emissions.[4] The prerequisite is that these "green" procedures are well embedded in the flight manuals and pilot training.

These opportunities may be adopted during flight operations when considered feasible and safe by the pilot. The decision to implement them depends on the specific situation, including factors such as weather, required equipment and the availability of ATM and airport facilities associated with each flight, aircraft and crew. Examples of these operational measures for the reduction of aviation CO_2 emissions include:

- Flight Planning And Fuel Reserves
- APU Usage
- Delayed Engine Start
- Aircraft Towing
- Optimized Climb Speed
- Continuous Climb Operations
- Cruise Speed Optimisation
- Optimised Flight Routings
- Weather And Wind Updates
- Continuous Descent
- Performance Based Navigation
- Reduced Flap Landing
- Delayed Flap Landing
- Idle Reverse Thrust
- Reduced Engine Taxi-In
- Centre Of Gravity Optimization
- Adjusted Potable Water Uplift
- Catering And Waste Tank Service

Advances in computerized flight planning, flight management systems (FMS), improved in-flight support and increased accuracy of weather forecasts have significantly enhanced pilots' ability to optimize operational efficiency. These improvements offer opportunities to optimize fuel planning (and reduce carrying extra fuel) and the selection of nearby alternate without compromising safety.[5] A fuel consumption monitoring program may reduce or refine the planned taxi fuel and required contingency fuel based on specific aeroplane and route data. **Ultimately,** the pilot-in-command has the authority to determine the final amount of fuel carried on board, and to increase the minimum fuel warranted for a safe flight or for operational reasons.

During the actual flight, the pilot may optimize the flight altitude, routing and cruising speed, depending on operator's needs and the flexibility of the Air Navigation Service Provider(ANSP). Trajectory-based operations (TBO) are expected to streamline this concept in the future. This requires updated enroute weather and wind information, and close collaboration with the operator/ dispatchers, the flight crew and the ANSP during flight. For the flight crew to actively manage the flight in a safe and sustainable way, data-communication and on-board flight management systems and an electronic flight bag with flight optimization tools should be available.

Ground operations can be made more fuel-efficient, but they generally require facilitation through by airport equipment and/or proper coordination and communication. For example, the reduced use of the Auxiliary Power Unit (APU) on board, requires suitable external ground equipment at the parking position for electric power and cooling of the aircraft. The implementation of Airport Collaborative Decision Making (A-CDM) and flow management can enable delayed aircraft engine start, but requires extensive communication and collaboration between the airport, ANSP and operator. This may limit the flexibility to accomodate last-minute changes.

One engine-out during taxi-in may be an option for a pilot, when this procedure is clearly outlined in the operating manual. It is then up to the pilot to decide if the circumstances are favorable to apply this procedure - lower aircraft weight, and no crossing runways, slippery apron, tight turns into gate positions, or aircraft technical deficiencies. Engine-out taxi-out procedures, on the other hand, involve more challenges: higher aircraft weight, greater workload for engine starting, the need for engine thermal stabilization, delayed checklists and system checks, and the absence of ground staff assistance.

Typically, the aircraft is certified with more than one standard landing flap setting. Choosing a reduced landing flap selection can decrease fuel consumption and reduce noise exposure during the final approach segment. However, this choice depends on various factors, such as aircraft weight, the runway length and runway conditions and the atmospheric/wind conditions. With reduced landing flaps, the aircraft will approach at higher speeds which will likely impact the runway occupancy time and the use of reverse thrust after landing.

The selection of idle thrust reverse upon landing will increase the landing distance and brake wear but reduces engine noise and fuel consumption. On a long and dry runway, this technique may be safely applied. However, this procedure should never be mandated, and full reverse thrust should be available for safety reasons. The pilot should be trained to use full reverse if circumstances require doing so.

Aircraft maintenance can also impact fuel consumption. The consequences of some aircraft deficiencies may be clear and relatively small – such as a missing fairing, which leads to a slight increase in drag and a clear fuel penalty. Over time, with frequent flights, this can lead to considerable fuel costs. For other deficiencies, operational expertise is required to assess the potential consequences – such as a lack of Reduced Vertical Separation Minima (RVSM) or Performance Based Communication and Surveillance (PBCS) capabilities, which may result in significant fuel penalties due to flight planning constraints.

Note. Future contrail management to avoid the warming non-CO_2 effects of persistent contrails, will entail several scientific and operational challenges. Any operational strategy should be carefully designed to address the uncertainties in forecasting and modeling, while also considering the impact on flight safety and flight efficiency and operational requirements.

Pilot training

Pilot training plays a crucial role in facilitating fuel-efficient operations and raising awareness on the environmental impact of aviation. Both ab-initio training and recurrent training should incorporate the environmental opportunities and relevant operational implications.

Continuous descent operations can be planned efficiently when the aircraft performance characteristics are well-known, and the capabilities of the aircraft automation and flight management are well used, and the flight path, speed and aircraft configuration changes are well managed and anticipated. This requires pilot and air traffic controller training, and situational awareness, specifically of parameters such as distance to go, expected routing, number in traffic and effects of wind patterns.

Specific navigational procedures, based on Required Navigational Performance - Authorization Required (RNP-AR) standards, will enable more direct and efficient departure and arrival routes, especially in congested airspace. These new standards require both pilot training and associated aircraft navigational capabilities.

The feedback of anonymized fuel and flight data statistics can assist in creating awareness among both the pilot and the company, facilitating more efficient fuel and flight planning. For example, the amount of contingency fuel, the amount of fuel required to compensate for unforeseen factors, may be reduced using fuel consumption monitoring data specific to each aircraft and route. This data ensures an appropriate statistical coverage of the deviation from the planned to the actual trip fuel.[6] The use of these statistics should be supported by airline's Flight Data Analysis Program (FDAP) embedded in a fully established just culture.[7]

Future outlook

IFALPA anticipates an enhanced role for the flight crew in the future, flexible and dynamic flight planning aimed at improving airspace capacity and flight efficiency. Especially on longer flights, route re-negotiation and adaptation during flight based on the operator/pilot's requests and updated weather forecasts, could significantly benefit flight efficiency. The Pilot in Command will remain responsible for the safety of the flight even when certain functions are delegated to automation.[8]

Looking ahead, future assessments, should consider the changing aircraft equipage and changing ATM environment. New airspace users will play an important role, such as advanced air mobility (AAM), unmanned aircraft, supersonic transport (SST), commercial space operations and these new users must be accommodated. These emerging technology aircraft may affect flight operations and environmental performance of conventional aircraft if not properly integrated.[9]

[1] ICAO Doc 10031 Guidance on Environmental Assessment of Proposed Air Traffic Management, 2014.

[2] IFALPA Position Paper Safe and Sustainable Aviation, 15POS14

[3] IFALPA Position Paper Long-term Aspirational Goals for CO_2 Reductions, 22POS03

[4] ICAO Doc10013 Operational Opportunities to Reduce Fuel and Emissions, 2014

[5] ICAO Doc 9976, Flight Planning and Fuel Management (FPFM) Manual, 2015

[6] ICAO Doc 9976 Flight Planning and Fuel Management Manual, 2023

[7] IFALPA Position Paper Pilot Self-Assessment Systems, 19POS18

[8] IFALPA Position Paper on Implementation of the Future of Air Traffic Operations, 21POS06

[9] IFALPA Position Paper, Introduction of Emerging Technology Aircraft in Civil Airspace, 25POS10