QF1

A recent study has revealed that the application of operational fuel saving imposes a number of latent performance impairments on the flight crew.

Majority of the crew participating in a research were of the opinion that the **operational fuel saving should be assessed in terms of flight safety relevance prior to implementation**.

Norwegian Airlines fuel saving and safety

Norwegian has been named the Most Fuel-Efficient Airline on Transatlantic Routes by the International Council on Clean Transportation (ICCT) twice.

The main issue was that we wanted to “realize” fuel efficiency, and we couldn’t do that with a system just telling management what flight crew are doing or not: we wanted to get that information to the pilots themselves.

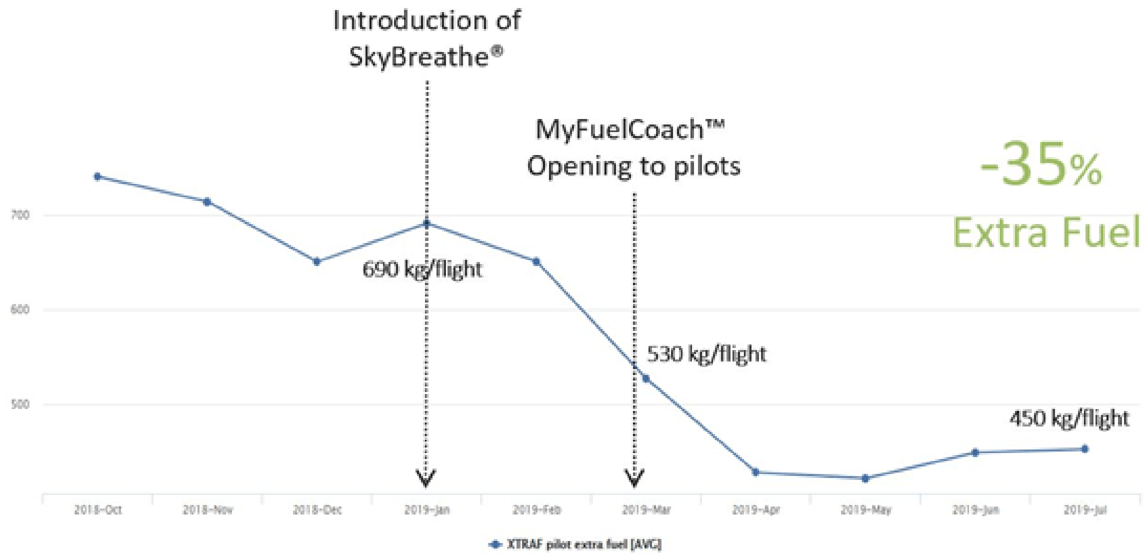
The fuel-saving manager says” **We wanted pilots to be able to see what they were**

doing well and what they were able to improve. Since the flight crew is at the sharp end of the operations, we also wanted them to be able to provide feedback through the application“.

Due to complexity of flight operations especially in complex airspace it is very important that the fuel efficiency system truly understands the conditions the flight crew operates in. So Norwegian needed a system monitoring the weather conditions and automatically detecting that some fuel saving best practices are not applicable in some scenarios, and then closing the loop over Standard Operating Procedures.

They chose skybreathe.

Norwegian also wanted our fuel efficiency system to not propose to the pilots to apply a fuel-saving best practice contrary to our safety policies.



Pilot Extra Fuel application

Qantas slammed for runway excursion at Bangkok (1999)

The ATSB report says that the principal factors in the accident include:

lack of runway condition information. The wet, un-grooved runway caused **aquaplaning**; loss of visibility in heavy rain as the aircraft descended through 200ft (60m); airspeed was 15kt (28km/h) above target at the runway threshold, and the aircraft was 32ft (9.8m) higher than profile, but this was still within company tolerances;
the flaps were set at 25° (a low setting) and the engines after touchdown were **only selected to idle reverse**.
These are company **cost-cutting practices**; the captain decided to conduct a go-around from 10ft above the runway in a sudden heavy shower, but then to abort it after the wheels contacted the runway. In the resulting confusion the crew did not select reverse thrust. They also inadvertently disarmed the auto-braking system by failing to retard one power lever fully to idle.
The report comments: “In such conditions and without reverse thrust, there was no prospect of the crew stopping the aircraft in the runway distance remaining after touchdown.”

The aircraft touched down 636m beyond the target point on the 3,150m runway and overran the 100m stopway at 88kt, stopping 220m beyond it.

Operational cost

Over the last few years, the reduction of operational costs and control of pollutant emissions have become central issues for the commercial aviation industry, and as a result, airlines have been increasingly focusing their attention on operational fuel saving techniques.
However, even though the practical implementation and economic potential of these

techniques have been exemplified in a number of papers, **little research has been dedicated to a systemic investigation of the effects of operational fuel saving on the human component of the system, i.e., the flight crew of an aircraft.**

Unprecedented growth

Driven by unprecedented growth rates and constantly evolving markets, commercial aviation is one of the most competitive business fields worldwide. The profit margins are so slim that the airlines are forced to deploy maximum available options for saving cost. The fuel cost being one of the highest, every effort is made to reduce the fuel burn at every stage of the flight.

Contemporary research has identified an increasing number of fuel saving-related safety issues in commercial air transport, underlining that new safety challenges have emerged. Worldwide demand for commercial air transportation is expected to increase over the next two decades implying that the total number of aviation mishaps will likewise increase regardless of low accident rates.

The research

The online questionnaire served two main purposes, besides collecting real world data the aim was to investigate the flight crews' motivational factors towards operational fuel saving. The link to the online survey was disseminated to all identified commercial A320 operators in Europe via different distribution channels such as direct email, pilot forums. The simulator experiment was conducted in an Airbus A320 Level-D full flight simulator. The primary purpose of this experiment was to measure the flight crews' performance (as operationalized through the constructs of subjective mental workload, situational awareness and human error) under the application of the respective fuel saving techniques in a line oriented flight scenario.

The flight from Hamburg to Berlin constituted the experimental part of the scenario and included the manipulation of the independent variables, i.e., application of the respective fuel saving techniques.

The flight from Hamburg to Berlin was performed according to the Standard Operating Procedures of the aircraft including the application of the following supplementary fuel saving techniques: Single Engine Taxi Out, Packs Off for Take-Off, Flaps 1 Take-Off (instead of Flaps 3), Reduction of Acceleration Altitude from 1.500 feet to 800 feet, Visual Approach, **Flaps 3 Landing (instead of Flaps Full)**, Idle Reverse (instead of Full Reverse), Single Engine Taxi In.

Results

Findings of the Online Survey

More than 90 per cent of the subjects were of the opinion that **operational fuel saving should be assessed in terms of flight safety relevance prior to implementation**, while more than 40 per cent of the test persons reported that **they have experienced flight safety relevant issues and/or degradations of personal performance during its application.**

The answers of Management Pilots were in some cases directly opposite to those of all other ranks.

The analysis of extrinsic rewards revealed a rather **low degree of perceived positive reinforcement, as more than half of the respondents did not feel their fuel**

saving efforts to be appreciated by their company. Beyond that, more than 40 per cent of the test persons reported perceived pressure to conserve fuel.

Simulator Experiment

The **human factors-related findings** of the simulator experiment conveyed a highly insightful picture of operational fuel conservation, as they **disclosed a number of potentially hazardous and largely unrecognised effects associated with the topic of interest.**

An **increase of subjective mental workload**, which provides reasonable evidence to believe that operational fuel conservation basically imposes additional cognitive demands on the flight crew.

Simulator data further revealed that flight crews are basically able to deal with **additional cognitive demands imposed by the application of the respective fuel saving techniques, but only up to a certain extent.**

The degree to which increased demands imposed by a particular fuel saving technique will result in decreased performance was found to be not constant, but to vary significantly. In particular, single engine taxi operations and **visual approaches with reduced landing flap setting were found to be especially error-prone and characterized by a mean workload value that was higher than that for a dual-engine go-around maneuver**.

As these fuel saving techniques were reported to be applied most often in the field, it can be hypothesized that f**light crews realize " what can be done safely and what cannot be done safely"** and thus avoid potentially dangerous or demanding situations.

The human factors-related impacts of operational fuel saving should not be viewed as an immediate and obvious threat for aviation safety, but as a latent, hidden condition that has the potential of impairing the safety of flight.

It is currently solely the flight crew, or more precisely, **the combination of their**

cognitive flexibility, workload compensation capability and the careful selection of when and when not to apply a specific fuel saving technique that determines the safety and efficiency of the "system component" operational fuel conservation.

mindFly analysis

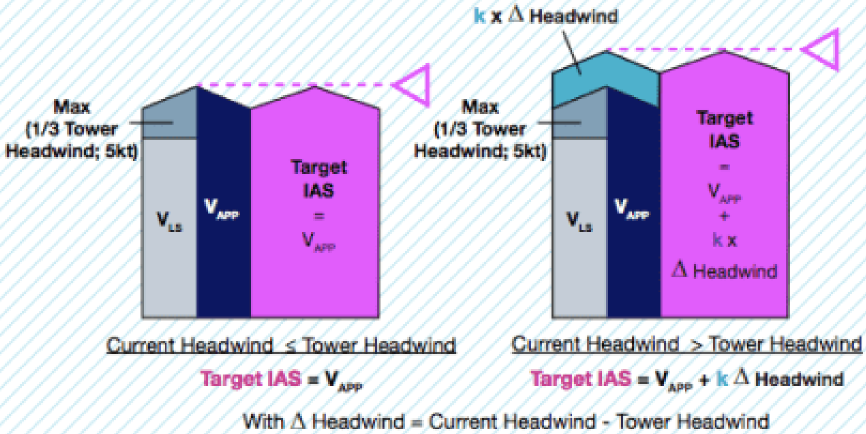
While fuel savings translate to money saved, there is a need to determine the human factors impact. There is a need to grade the fuel savings from low risk to medium or high risk depending on the phase of the flight, cognitive work load and other factors.

The crew needs to understand that they need not apply some of these fuel saving techniques if operationally limited or more importantly limited due to human factors. Most safety related incidents take place due to application of such procedures without much thought or determining consequences.

A320 NEO has a slower deceleration rate during flare due to the ground effect. Airbus has introduced the K factor of 0.33 to the IAS target to compensate for this but there is a slight variation in thrust in gusty conditions.

(fig.21)

Ground speed mini function



Aircraft type	k
A320ceo	1
A320neo	0.33
A330/A340 Above 400ft	1
A330/A340 Below 400ft	Reducing from 1 to 0.33 in 25s
A350	0.33
A380	0.33

Why is there a different 'k' factor for ground speed mini depending on the aircraft model?

The factor of 1 used on A320ceo aircraft could not be used for the other aircraft models due to differences of their deceleration capability. The A320ceo has a stronger deceleration capability when compared to A320neo, A330/A340 family aircraft, A350 and A380 aircraft.

In the case of a strong ground effect, a lower deceleration capability may lead to an excessive speed at flare. For example, a 20kt headwind at 200ft that reduces to 5kt on ground (corresponding to the 5kt tower headwind inserted in FMS PERF APPR page), a factor of 1 requires a deceleration of 15kt to reach V_{APP}. With a k value of 0.33, the aircraft only needs to decelerate by 5kt to compensate its lower deceleration capability. It reduces the risk of excessive speed at flare. The drawback is that there is a slight increase in thrust variations in gusty conditions, since the speed increment will not be sufficient to counteract the IAS increase due to a gust. The best overall compromise was demonstrated to be a 0.33 factor.

K Factor for A320 NEO

Final reserve fuel based on archaic data: Unsafe for future growth mindFly

References: Daniel Vogel1,2(&), Ivan Sikora1, and Hans-Joachim Ruff-Stahl2