The rising price of crude oil and kerosene fuel and pressure on airlines to reduce carbon emissions is bringing increasing attention on techniques and ways to reduce fuel burn. Analysis shows that simple changes to a few operational procedures can deliver substantial savings.

Tweaking operational procedures to reduce fuel consumption

The focus on the European Emissions Trading Scheme (ETS) has brought the whole operating and fuel efficiency debate to the fore. It has provided companies offering software for such enhanced capabilities an opportunity to sell. This is relatively simple compared to the complexity of the overall software package.

Fuel burn reduction

Marcel Amherd of Zurich-based Swiss49 says that more and more airlines are discovering the benefits of software which pulls flight operations data together and analyses it. Swiss49 has collaborated with a leading flight data monitoring (FDM) company "to aggregate these huge amounts of data online."

Amherd's team, which comprises experienced airline pilots and IT experts, has been running a fuel conservation project for the past two years for a customer airline. The airline had to provide flight recorder data via its FDM infrastructure (Aircraft Integrated Monitoring - or AIMS), for at least 50% of the flights operated by each of its sub-fleets. It also had to provide all the necessary documents, including flight operations procedures and policies, and technical manuals.

The information provided contained 34 parameters (17 mandatory, 17 optional) and included past data to allow the calculation of baseline fuel consumption for each sub-fleet and for each 'topic'. (A 'topic' is something that can affect fuel consumption, for example, the use of the idle thrust reverser during the landing roll.)

The aim of the project was to reduce the airline's fuel consumption by 2% within a year. Thirty-six fuel conservation measures were identified *(see table, page 46)*. Sixteen of these were rejected, four were not considered, and 16 were implemented. It was projected that the airline would make annual savings in fuel expenditure of $8.2 million. This saving came from a 1.48% reduction achieved 12 months after the start of the project. The airline operates 50 short-haul and 20 heavy long-haul aircraft, and has an annual fuel bill of $554 million.

The 2% improvement was not achieved, however, according to a 'white paper' produced by Swiss49. "This is because fuel consumption is influenced by many factors, and it proved very difficult to measure or make any statements about the influence of specific fuel conservation measures without taking into consideration the contributing factors affecting fuel consumption itself," says Amherd.

So the team adopted a 'characteristic fuel factor' of 'fuel per distance and revenue payload', as used by the International Air Transport Association (IATA). Over 12 months this factor was improved for the airlines' three sub-fleets by 3.5%, 5.5% and 4.6%.

The project concluded that this new approach was very worthwhile. With two years' worth of quick access recorder (QAR) data, a statistical test of the fuel factors showed, with a probability of 99%, that the results achieved were not down to chance.

For each flight more than 3,000 measurements had been taken with a range of outcomes, or operational efficiency measures. These were factors such as poor fuel economy being identified for a particular aircraft relative to others in the same fleet. The white paper also lists many safety- and maintenance-related events, which further illustrate the complexity of the task.

One example of a flight data efficiency analysis was given for an A340 going from the start of take-off roll to an altitude of 33,000 feet. This was with early flap extraction in the climb to save fuel. The savings represented 0.1% of total project savings, or about $675,000 of fuel cost a year. There was a 1,000kg lower fuel consumption by retracting the flaps at 1,500ft rather than 3,000ft. This translates into a potential annual saving for 100 flights a month (200nm average distance for the climb segment) of 960 tonnes of fuel per year. That is, out of 100 flights each month, pilots retracted flaps early in 80 of them. This saves 960 tonnes per year, which is equal to about 320,000US Gallons. At a price of $2.12 per gallon, a saving of $675,000 is made.

Another interesting analysis by Swiss49 looked at the cruise Mach number used. It identified a group of 10% of flights flown at M0.826, compared to M0.818 which was used for 60% of flights. These 10% of flights were non-optimal, and therefore caused significant additional costs across all flights in a year.

Fuel is not everything

Air Support

Jens Pisarski, director of sales & marketing at Billund, Denmark-based Air Support, stresses that what is required is a holistic view of operations, not just fuel savings, which represent less than half the problem.

He says that Air Support's system takes into account a wide variety of factors, the main three being: the cost of maintaining the aircraft, engines, and landing gear; the cost of financing the

SWISS 49 PROJECT: OPERATIONAL PARAMETERS FOR POTENTIAL FUEL SAVINGS

- Flight-planning system accuracy
- Individual aircraft fuel-burn accuracy (engine condition monitoring, aircraft performance monitors and fuel bias)
- Fuel on board and fuel uplift
- Fuel over destination
- Planned efficiency of flight dispatchers
- Zero Fuel Weight and Payload Optimisation
- ATC (Route, Flight Level, Holding Delays)
- Pilot technique
- Cost Index Flying (i.e. Speed selection)
- Alternate selection
- Contingency fuel calculation
- Aircraft fuel-burn management
- Strategic tankering
- Route comparison - planned v flown
- Flight schedule impact on fuel efficiency
- Contingency fuel monitoring
- Redispatch operation (fuel at decision point)
- APU usage when aircraft moving
- Airport tailored taxi fuel, delays, gate hold
- Runway selection vs taxi times
- Full/reduced thrust take-off
- Reduced take-off flaps
- Lateral and vertical flight profile management
- Cruise speed management
- Wind application by FMS
- Landing weight
- Engine anti-ice
- ATC restrictions (early/late descent)
- Reduced flaps landing
- Engine out taxi-in
- Terminal airspace ground track distanced (dep/arrival)
- Cost of weight, monitoring of unknown load (unregistered cargo)

aircraft; and the cost of fuel, which usually represents less than 50% of the total.

"So to operate the aircraft to get the lowest fuel burn does not necessarily help in reducing total operating costs if you operate the flight in such a way that the flight is longer, and other costs are higher." He questions why an airline would fly to Flight Level 350 when the climb from FL250 to FL350 is the slowest part and overall the flight could be more costly.

"You have to calculate the flight time related to direct operating costs without any fuel included. This gives the dry operating cost. For all possible Flight Levels you then need to look at fuel burn per minute on each trip, then add flight time costs to fuel costs. The Flight Level which gives the smallest figure is the optimum.

"Most flight-planning systems cannot do this," continues Pisarski. "Our system also includes the costs of tankering so that you can look at fuel costs at each airport." He gives an example calculation where extra contingency fuel carried (over the minimum for the trip, reserves and diversion) is cut by 100kg from 2.0 tonnes to 1.9 tonnes per trip.

Given that carrying extra fuel adds 4% to fuel burn, the total amount saved for a monthly operation of 100 flights of 1.5 hours is: 1.5 x 100 x 4% x 100kg. This is equivalent to a saving of 600kg a day, or 216 tonnes per year.

If only 1 tonne of contingency fuel was used on 85% of flights (the other 15% being where there are operational uncertainties such as bad weather), then the total saving ends up being 2,160 tonnes a year, says Pisarski. The system compares fuel prices with tankering costs and works out the best solution, always allowing for three or four additional passengers. Pisarski notes that pilots often opt for more fuel than they need, and that there are large savings to be made by carefully managing fuel uplift.

"The Air Support system also takes into account the navigation and route charges when it looks at the total cost of the different route options," says Pisarski. "About 20 hours before departure our system goes in to see which routes are available and what the costs are at each level based on passengers and payload expected. Then it will pick the cheapest combination of route and flight level." It then re-evaluates every hour until two hours before departure, although usually little tends to change from the night before.

"The range of costs depends on aircraft type. For example, a 737 route optimisation can often provide a saving of EUR 50-250 per leg in routeing cost. While this does not sound like a lot, if EUR 75 are saved per flight, this means that an airline flying 100 legs a day for the fleet can save EUR 2.7 million a year. So our system can pay for itself 27 times over within the first year, assuming the cost of an Advanced Airline Solution for a 737 fleet," says Pisarski. He adds that airlines can pay a licence fee or buy the software with annual update charges thereafter.

ETS is a new web-based capability. Pisarski comments that Air Support does not see the need to consider ETS costs in calculations because distances are fixed at great-circle, and airlines want to maximise their allowances anyway. "You can only reduce ETS charges by reducing actual fuel burn, so you need to buy more efficient aircraft," he says.

FuelPlus

Klaus-Peter Warnke of Hannover, Germany-based FuelPlus says that its current FuelPlus version 4.0 includes an emissions management module. FuelPlus will soon be introducing version 5.0, which is in the final stages of development and will be out early next year.

"Airlines can save millions of Euros per year by optimising and automating their fuel management process," says Warnke. "There is a big misunderstanding about that, however, since it should include all activities related to fuel. These include supply, budgeting, tendering, operating plan, contracts, services and transportation. You need to monitor everything."

"Fuel efficiency is important," continues Warnke, "and you need to keep track of fuel figures on a flight event level. The information in FuelPlus is very detailed. For each fuel delivery, for example, based on uplift and consumption, we can combine the data with contractual information to calculate actual costs. Based on this we do data accumulation/aggregation up to route level, fleet level or area level, for example. So a foreign operator can easily monitor its flights into Europe.

"Fuel in tanks is information that we load as part of the flight event record, including the fuel remaining," adds Warnke. "This is calculated by onboard measuring devices and transmitted to FuelPlus, over the aircraft communication and reporting system (ACARS) for example. The airline needs to configure its ACARS system for this, so that the data are sent automatically. This transmission is triggered by events such as closing the doors, take-off and touchdown. This is then monitored by the airline directly using its ACARS ground module.

"Potential savings come from different areas," says Warnke. "We are able to achieve savings of at least 1% of an airline's annual fuel budget, which could be equivalent to more than $10 million." Fuel Plus is used by various airlines including Lufthansa, KLM Air France, Austrian, Swiss, ANA, Malaysia Airlines, Kenya Airways, SAA, Avianca, AirTran and Canada's Westjet (the most recent customer).

"Our ETS module allows airlines to monitor and report emissions and collect revenue tonne-km (RTK) data for use in the calculation of the benchmark," says Warnke. "It is a natural extension to include emissions as well. It takes care of RTK data based on payload and distance information. We have also implemented two things for great-circle distances: you can upload a datafile from Eurocontrol; or FuelPlus can calculate distances since it

By just focussing on just a few of the 34 parameters that affect fuel burn, airlines can cut fuel consumption per trip by a few percent or fractions of a percent. Over an airline's annual operations this can translate into savings worth millions or hundred of millions of dollars.

has all the destination co-ordinates built in."

Warnke says that lots of airlines believe that they can manage ETS using nothing more sophisticated than Excel spreadsheets. "I am not optimistic they can do it, because you need to manage exceptions and take care of detailed calculation rules. Verifiers will need checks and balances in the system too, and the FuelPlus system was just approved by the verifier LRQA," says Warnke.

"Although European airlines are well prepared, there is a lack of interest and focus among non-European airlines, who risk missing out on free allowances," adds Warnke. "I'm concerned in the short term that some could face serious problems. The free allowances represent a lot of money. Lufthansa has calculated, for example, that it could need $250 million per year just for buying the additional allowances, which comes to $2.5 billion over ten years.

"US airlines are particularly annoyed that they are included in the scheme," says Warnke. "I believe that the US will come up with its own scheme so that it can collect fees in the US. The directive also contains provisions to enter negotiations to avoid double charging, so that airlines can be assured that they will not be charged twice."

Other providers of software which help minimise operating costs and offer fuel management and an ETS solution include OSyS, Teledyne and BSi.

ATC advances

Lockheed Martin

According to Lockheed Martin, the Advanced Technologies and Oceanic Procedures (ATOP) system is fully operational in New York, Oakland and Anchorage oceanic airspace and enables system efficiencies that lead to emissions reductions. The company believes that it is the most advanced system now available.

One of the main benefits of the system is that it allows allow users to choose optimum routes (User-Preferred Routes, or UPRs), which will reduce airlines' fuel consumption. Projected annual savings, according to the Federal Aviation Administration (FAA), include:

- North America to South Pacific up to 9.61 million kg of fuel and 30 million kg of CO2.
- Los Angeles to Singapore up to 1million kg of fuel and 3.16 million kg CO2.
- Australia to Japan, up to 1 million kg fuel and 3.16 million tonnes CO2.
- New Zealand/New Caledonia to Asia, up to 2.9 million kg fuel and 6.6 million kg CO2.
- Asia to Hawaii up to 2.88 million kg fuel and 9.1 million kg CO2.
- Japan to Brisbane/Sydney/Cairns up to 1.89 million kg of fuel and 5.97 million kg CO2.

Since September 2007, Air New Zealand has been saving up to about 600kg per flight by using UPRs to and from Tokyo and Osaka in Japan. Over 12 months this equates to an annual saving of 770 tonnes of fuel on operations to Japan, and also saves 320 tonnes on the Shanghai route.

UPRs were also developed for the Russian Trans-East (RTE) routes from October 2007. Since then three flexible tracks have been published daily, with savings of up to 40 minutes per flight. February 2008 saw UPRs developed between California, Vancouver, and six route entry points, according to the FAA. Participating aircraft have realised savings on average of seven minutes' flying time, equivalent to 1,180lbs fuel, and are now able to carry an additional 1,675lbs of cargo.

Another example of the various advances made within ATOPS is Oceanic Tailored Arrivals (OTAs), trials of which started into San Francisco in December 2007, running through to 2008. On average, 777s used 1,303lbs less fuel and 747s 2,291lbs less fuel. In September 2008, Miami Tailored Arrivals started and October 2008 saw the start of development of Los Angeles OTAs. Tests at LA were completed successfully in March 2009, and operational trials were due to start in November 2009.

Summary

Just a few examples of changes in simple operating procedures shows how fuel burn can be reduced by a few percent or pecentage points on a flight. Once more factors affecting fuel burn are taken advantage of, and the number of flights in an airline's operation over a year are considered, the potential savings airlines can make can total several millions of dollars. Airlines' interest in reducing fuel consumption is bound to magnify with the advent of the EU's ETS. AC