Fuel Savings: More Than Just Winglets

As the price of oil hits stratospheric levels, it's increasingly incumbent on the MRO sector to assist aviation's efforts in reducing fuel consumption. Here's how the maintenance world is stepping up to the plate.

BY KATHRYN B. CREEDY

Airlines everywhere are facing another fuel crisis this year, after a 33 percent climb in the cost of jet fuel in the past several months. While many airlines such as JetBlue and Southwest are responding with the acquisition of more fuel-efficient aircraft, others such as Delta are relying on older MD-90s, making fuel conservation techniques of paramount importance to keeping costs in check.

During the last few years, airlines have done a masterful job of reining in costs. The numbers speak for themselves. Cost per available seat mile (CASM) last year rose between 0.2 percent at American to 11.4 percent at AirTran, while CASM without fuel as a factor was between flat at Delta and up to 5.9 percent at JetBlue. As impressive as this is, Delta alone is facing a $1 billion increase in fuel costs in 2011, which threatens its efforts for sustainable profitability.

Oil rose beyond $100 per barrel in February; recent unrest in the Middle East does not help matters. Every dollar increase per barrel drives an increase of between $415 million and $475 million in annual expenses, while every penny increase per gallon means increased annual expenses of between $175 million and $200 million. While U.S. airlines have transformed themselves to make money at $97/bbl and revenue increases have far outpaced cost increases, there remains little room for complacency.

Managements have a few arrows in their quivers to address the increased costs, including another round of capacity cuts as well as fare increases. However, nothing works like dropping fuel consumption, despite complex fuel hedging strategies, as evidenced by the comments during 2010 earnings calls.

Delta has already pulled the trigger on what is probably the first of many capacity cuts this year. Airlines have not only been successfully raising fares but are adding fuel surcharges, which United CEO Jeff Smisek sees as a much easier sell than fare hikes because everyone knows the impact of fuel increases.

Nonetheless, the aviation industry must do more to reduce fuel consumption and that is where MRO centers, such as Lufthansa Technik and Delta TechOps, come in. The MRO sector can help in a variety of ways, as explained below. What's more, clever after-market companies, such as Axiam, are devising ways to rebuild components that not only achieve greater fuel savings and emissions, but also reduce maintenance costs by keeping engines on the wing longer. These efforts, many of which seem small, grow large in the aggregate.

Engine Cleaning

Of course, the first reaction to saving fuel is engine cleaning, according to AeroStrategy's David Stewart, who indicates that most engine manufacturers are offering power washing. Pratt & Whitney took the lead on introducing on-wing, at-the-gate cleaning years ago and the method has gained widespread acceptance worldwide.

"Besides winglets, the main thing is engine wash which was introduced partly as a safety measure and partly to keep the engine lighter," Stewart said. "In addition to the engine makers, MROs such as Lufthansa Technik are developing such products. Besides engine overhaul, it's all about engine wash. Apart from winglets, it's all about the engine."

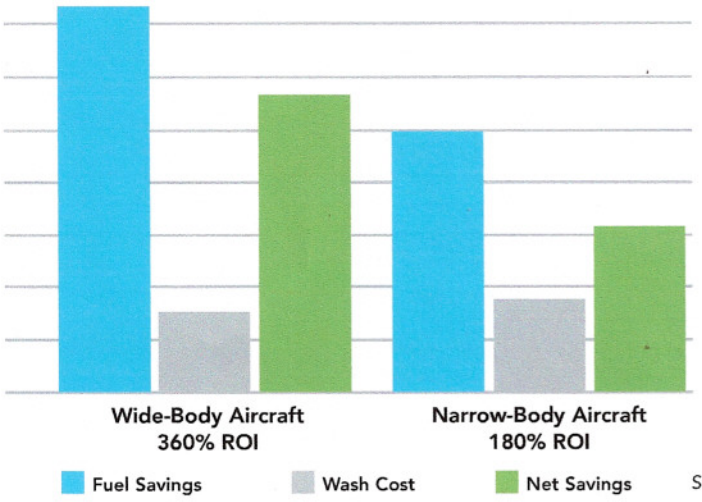
Many performance advantages are gained by engine washing. P&W's EcoPower engine wash promises efficiencies in both low- and high-pressure compressors, providing for lower turbine temperatures up to 15-degrees C for exhaust gas temperatures and longer revenue service time. It also provides up to 1.2 percent improvement in thrust-specific fuel consumption and a corresponding reduction in CO^2 — equal to CO^2 absorption of 250 acres

Aviation Finds Itself Over a Barrel

Jet Fuel 2010	Consumption		Expense	Avg. Paid Price (U.S. DOT)		Avg. Market Price (U.S. EIA)*			
	Gallons (bils)	% Chg. Yr/Yr	$ USD (bils)	¢/Gal.	% Chg. Yr/Yr	NYH	USG	LA	¢/Gal.
Jan	1.354	(3.1)	2.979	220.0	25.2	209.7	205.2	208.0	207.6
Feb	1.220	(4.2)	2.640	216.4	17.3	202.4	198.9	202.4	201.2
Mar	1.433	(0.6)	3.158	220.4	33.3	215.9	210.8	214.0	213.6
Apr	1.388	(2.2)	3.195	230.3	32.2	226.5	224.3	229.8	226.9
May	1.470	2.2	3.426	233.1	34.7	210.3	206.3	211.9	209.5
Jun	1.506	0.1	3.346	222.1	18.5	210.4	205.8	216.1	210.8
Jul	1.583	(0.4)	3.505	221.4	16.5	206.0	201.9	212.1	206.7
Aug	1.562	4.4	3.484	223.1	10.6	210.9	208.3	213.3	210.8
Sep	1.436	5.7	3.155	219.7	9.4	215.7	211.6	218.6	215.3
Oct	1.467	4.7	3.399	231.7	15.9	227.7	225.0	236.1	229.6
Nov	1.400	6.9	3.145	224.6	5.5	235.0	232.0	240.7	235.9
Dec						250.7	245.3	256.1	250.7
Total	15.820	1.3	$35.434	224.0	19.4	218.7	215.0	222.2	218.6

*EIA=Energy Information Administration; NYH=New York Harbor; USG=U.S. Gulf Coast; LA=Los Angeles

EcoPower's Economic Advantage (typical operation)



Source: Pratt & Whitney

of rain forest. The company expects the process to wring out savings of three pounds of carbon emissions for every pound of fuel saved.

In 2009, EcoPower earned Frost & Sullivan's MRO product innovation, and the consulting firm indicated that it set the standard for such technology by revolutionizing the entire approach toward engine washing. Aerospace analyst Nathan Smith cited EcoPower's cost effectiveness, reduction in fuel consumption and environmental contributions as a milestone in the MRO industry.

The EcoPower engine wash system, offered through the Pratt & Whitney Global Service Partners network, uses a closed-loop system with pure, atomized water to wash aircraft engines, avoiding potential contaminant runoff.

Similarly, Lufthansa Technik is offering what it calls a revolution in engine cleaning, with Cyclean Engine Wash, which uses technology developed by the company.

"Engine washes have been an issue for some time now," explained Lufthansa Technik Head of Environmental Management Ralf Wunderlich. "Dust, pollen, sand, salt, chemicals, hydrocarbons and insects pollute an engine over the course of time, thereby reducing its performance. But as the engine must continue to produce the same performance, it is exposed to greater stress and wears out sooner. It consumes more kerosene and its exhaust gases are also hotter. After cleaning, an engine runs better again."

Until recently, aircraft engines were fully flooded with water in the process of cleaning. Including drying, this took up to five hours — too long to consistently carry out the engine washes required, explained Wunderlich, who added that Cyclean streamlines the process to less than one hour, for a better fit with airline operations. It also makes regularly scheduled washes more feasible. P&W's process also takes about an hour.

In the Lufthansa process, a rotating nozzle injects water directly into the dirty compressor, so that only 180 to 200 litres are needed per cleaning. Lufthansa Technik currently uses water alone but is investigating the addition of detergents. Beyond this, the company is currently evaluating the options for recycling the polluted water, something already done with P&W's EcoPower engine cleaning.

Lufthansa Technik promises that its process delivers a 0.5 percent reduction in kerosene consumption. On a short-haul aircraft, with 5,000 tons of annual fuel consumption, emissions are also lowered by 79 tons. A long-haul aircraft saves about 790 tons of CO^2.

This new technology gives Lufthansa the potential to cut its kerosene consumption by up to 25,000 tons a year, depending on the fleet. This is equal to avoiding 75,000 tons of CO^2 emissions. The silver lining is longer life spans and declining maintenance costs.

Lufthansa Technik is taking the Cyclean engine wash a step further.

A Delta airliner under maintenance in a Delta TechOps hangar

It is working now on a refinement using dry ice for even more thorough turbine cleaning, for even lower fuel consumption. The project promises to cut back on kerosene consumption and emissions by optimizing the compressor index. To achieve this, it is developing a 3-D flow simulation that encompasses all possible actions to develop the best combination of actions for a given engine.

Lufthansa is one of several airlines to emphasize component repair, to reduce parts acquisition costs. Its engine overhauls include the Advanced Recontouring Process (ARP), which focuses on compressor blades because they are exposed to more stresses that limit lifespan.

The company developed a computer-controlled, automatic grinding process using a laser beam to examine the blade and then restore it to optimized aerodynamic form. Lufthansa Technik says the restored blade works better than new ones. Compressor blade life is extended by 25 per cent. Kerosene consumption and emissions on Lufthansa's 747 and A340 fleets save 5,500 tons of CO^2 with the procedure.

Cleaning the Aircraft

In addition to cleaning and optimizing the engine, Lufthansa Technik is currently developing aerodynamic measures to keep the aircraft air flow as clean as possible. The MRO's Weight & Balance Engineering ensures the Lufthansa fleet saves 38,000 tons of CO^2 annually.

"For example, we have designed calculation methods to place containers, palettes and loose freight in an optimum manner aboard aircraft," says Wunderlich. "Using Optimized Load Planning, an aircraft is given its ideal center of gravity, which in turn reduces its air resistance."

The company's interior work includes reducing seat weights by about 1-2 kilos per seat, which saves 6,300 tons of kerosene and 20,000 tons of CO^2 annually.

Meanwhile, its exterior work includes smoothing all uneven surface areas on the aircraft shell, with particular focus on wing-to-fuselage areas. It also checks and adjusts control surfaces such as landing flaps and inboard spoilers, improving performance by reducing vortices.

Delta TechOps: Pioneer with Winglets

Delta TechOps is both airline and MRO, according to Fleet Engineering General Manager Jim Ganopulos, who works both sides of the house.

"Delta saved 28 million to 32 million gallons in 2010 from our overall fuel cost factors team initiatives program," he said. "We also save 7-8 million gallons on programs outside of winglets which are identified as key MRO fuel strategies."

At the $2.60/gallon for jet fuel cited in February, that comes to a market value of approximately $100-105 million, the vast majority of which is against winglet initiatives. Ganopulos explained that the company has a fuel council in which everyone must contribute fuel savings initiatives. These range from what he oversees to within Technical Operations, to Operational Control tinkering, to creative flight planning.

"TechOps has 10-12 different initiatives for either fuel savings or mission performance," he said. "Delta is very focused on fuel and it uses that expertise in its MRO business. Key to this is aircraft performance monitoring and engine control monitoring, for specific air range improvements. We calculate the SAR, which is the same as miles per gallon for a car in order to identify planes that are operating outside the peer group. We take the lessons learned and offer those services to other airlines and have been quite successful."

"The idea is to maintain engines at their optimum and if we see a shift in performance we notify the airline there is excessive fuel burn," continued Ganopulos. "Our flight operations performance engineering also identifies aircraft performing below par, which signals a need for maintenance. Everything within maintenance is rigged properly to ensure, for instance, that a flight control is not floating or faired inefficiently. There are also all sorts of checks we can do when we are alerted that an aircraft is not performing at optimum."

Delta has been doing winglets since long before they gained general industry acceptance, installing them on 727s in the 1990s when jet fuel was a mere 50 cents per gallon.

"They never got a lot of traction then and technically were difficult to support," he said, adding they involve more than just slapping them on the end of the wing. "They come with a lot of tangible requirements and the modification is close to 1,600-2,000 man hours. We now have 145 sets installed on Delta's overall fleet and in the future we are aiming for nearly 300. That gives us four to five percent fuel savings based on the type of equipment and mission stage length. We are very invested in deploying winglets with the fuel savings they give. The net savings are substantial."

Ganopulos took *Aviation Maintenance* magazine through the complex procedures to support today's winglet

installations, which include substantial increases in maintenance program man-hour requirements, to avionics flight management computers upgrades as well as adding flight control load relief systems to equipped aircraft. All this means the savings must be pretty substantial to warrant a 2,000 man-hour job and the ongoing continued airworthiness maintenance requirements.

"When Delta got into winglets, we were actually looking for increased range to go into markets we could otherwise not serve," he said. "We wanted our 757s to be able to go deeper into Europe and South America. We began realizing the fuel strategy and developed a blended strategy incorporating both fuel and mission capabilities."

He then turned to the many other initiatives Delta TechOps has incorporated into fuel savings programs, both for Delta and its other airline customers.

"We offer an aircraft performance improvement program package on the 777 which changes the aileron profile," he said. "We also do weight monitoring especially for potable water, tailoring it to the mission requirements and have gone a step further by removing redundant tanks from 767s and 777s. We also ensure the optimum aerodynamics by checking leading edge aerodynamic seals of all the primary flight controls to ensure we have as clean an aircraft as possible."

Delta TechOps also has played around with paint coatings, but found it not very feasible owing to the reapplication requirements. "Some claim a 1 percent performance improvement," he said.

Delta TechOps also does engine washing for customers, including Hawaiian, and takes full advantage of any performance improvements from airfoil and coatings changes in the compressor. In addition to washes, it also does component restoration on any components sensitive to fuel burn.

Achieving Engine Perfection

That's where Axiam comes in. Everyone knows engine monitoring is maintenance 101 for not only fuel savings but extending engine life, as indicated by Lufthansa Technik. Axiam takes it a step further, by providing tooling and software to ensure optimum engine core rebuilding. Delta TechOps has been an Axiam customer since the late 1990s.

"Competition among engine shops has intensified in the past decade as engine manufacturers have increased their presence," explained Axiam President & CEO Donald W. Lohin, describing painfully familiar problems. "Operators became more demanding, and the economic cycle has induced the need for greater productivity. Each shop can choose either to continue to build the engine core to runout limits as per the engine manual or, to adapt state-of-the-art technology to achieve straight, optimal builds for each set of parts. A shop can gain a competitive advantage by delivering quality engines at reduced cost by adopting Axiam's assembly optimization processes."

Building to runout limits contributes to high turn time, rebuilds, test cell rejects, high parts costs, high spares usage, assembly process inconsistency, excessive vibration, excessive engine wear, low EGT margins, rapid EGT

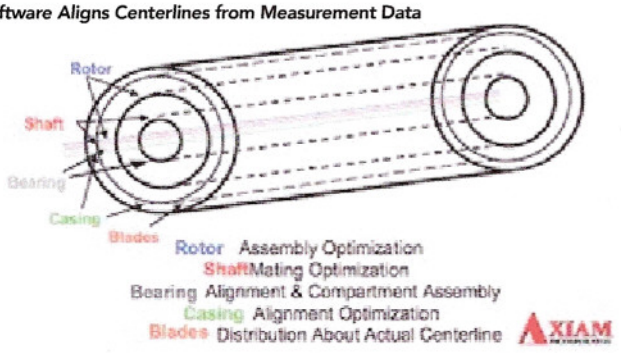
margin deterioration, bearing failure, oil leakage, blade and shaft rubbing, engine surge, and excessive fuel consumption.

Consequently, its proprietary engine core assembly processes not only provide an opportunity for more efficiency but one that produces more profitability for the aggressively competitive engine shop. "The cost savings for operators from improved SFC, EGT margins, vibration and wing time is especially desirable," he said.

"We provide tools for engine overhaul shops, engine manufacturers and the airlines themselves for the assembly of engine cores," Lohin said of the system used by American Airlines, United Services, Pratt & Whitney, Solar Turbines, Siemens, Tinker AFB, NASA, and Navair. "Most importantly, the tooling and software aligns the engine's dynamic structure to the casing so they are built to a common centerline as designed."

Axiam's tooling, measurement gauges, software and assembly procedures give a shop direct control over assembly

Software Aligns Centerlines from Measurement Data



process variables, according to company material, consistently resulting in repeatable, straight and optimal builds on the first pass. Axiam's unique assembly processes build the engine core (all rotors, shaft mating, bearings/seals, casing, and optimized blade distribution) so that the turbine's dynamic and static structures are aligned about the actual centerline of rotation. As a result, the shop can better manage blade-tip gaps.

Engine average improvements to pre-Axiam performance as observed in shops and test cell data include: improved assembly times (up to 60 percent); improved EGT margins (30-50 percent); reduced vibration (35-80 percent); a 0.55-3.0 percent improvement in specific fuel consumption; reduced spare parts replacement; elimination of test cell rejects due to vibration; improved engine quality; and, longer time on wing (10 percent).

Lohin indicated that in recent work with a large European airline, a project originally designed to improve and maintain engine exhaust gas temperatures has been so successful that the airline is now requiring an engine shop to which it outsources another engine model to use the Axiam system. He explained that one particularly difficult engine had been through five engine shops before being successfully tackled by the Axiam assembly process.

"When we got the engine core to our lab, we found distorted parts that were out of specification which no one else had caught," he said. "We called for specific machining instructions to repair the parts and what was a problem engine is now built straight. We expect that to work to our benefit and we are looking for other airlines who want to improve fuel consumption, EGT margins, pollution or vibration to do the same thing. The Axiam assembly process can achieve engine performance they otherwise couldn't achieve."

Taking Out Variables

"We identify the variables in the assembly process and change the process 5-10 percent to control for those variables getting assembly process consistency," Lohin said. "These changes are enough to make the process repeatable and allow the shop to have optimal build for each set of parts. Repeatability means you will always get the same optimal build results from the same parts and always on the first attempt. You no longer have to rely on the skill level of the individual maintenance technician which can vary a great deal."

"The airlines are not the only winners," Lohin said. "The technology provides a nice productivity opportunity for engine shops and airlines alike. Shops can now predict with more certainty how long it will take to build an engine core. Shop bottlenecks in the assembly are a thing of the past. A great deal of time is saved in the assembly area, balancing and test cell. United Services is a recent customer for the Pratt & Whitney PW2037 engine and it estimated a $1 million annual cost savings in test cell fuel consumed owing to reduced trim time using the Axiam assembly processes."

Airframers Consider Next Steps

Airbus and Boeing right now are tinkering with new equipment designed to achieve higher fuel efficiency and better operating costs. Bombardier is offering its own solution in the CSeries and Embraer is planning to react to Boeing's plans.

Meanwhile, the Russians and Chinese are developing their own solutions, all of which are possibilities according to Delta's latest aircraft request for proposal. While Airbus has introduced the A320neo, Boeing has been too pre-occupied with its 787 problems to offer a solution, except to say it prefers tweaking current products while awaiting the next step function that won't come until the next decade.

That means, of course, that MROs and clever innovators such as Axiam and Chromalloy will become that much more critical to achieving fuel efficiency (see Tool Crib, page 43).

Lufthansa Technik is already looking to the future with its Digital Cabin Model, a virtual reality cabin that offers the possibility of examining an individual component digitally to ensure a perfect fit before it is manufactured. This innovation would cut down on redundant manufacturing steps.

Lufthansa Technik also is working on a modular VIP/First Class seating concept called CompoSEAT, which uses high-performance composite fiber to lower weight considerably. Ultimately, it wants to apply the same technology to business and economy seating.

The company is also tinkering with fuel cell research. It is working with the German Aerospace Center (DLR) on two projects, testing the option of using fuel cells in real-world conditions.

Clearly, while there is much MROs can do right now to help airlines save fuel, there is more to come. AM

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