Economic decision making based on real-time costing is on the verge of materialising, as traditional cost-cutting programmes reach their limits. Early adapters are preparing for real-time costing and analytics to support the decision making in the Operations Control Center. With predictive analytics, costing irregularities will be manageable.

Boosting operations management with accurate real-time costing systems

Leading airlines manage disruptions to flight operations in the operations control centre (OCC), the hub control centre (HCC) or in a centralised combination of both with complex operations (OPS) solutions and optimisers. Modern OCCs also use business intelligence (BI) for key performance indicator (KPI) driven decisions with extensive analytics in back offices.

In today's highly sophisticated resource-, time- and safety-optimisation framework, OPS cost plays a secondary role. Airlines apply rough indicators and indexes, some randomly updated, to perform economic decisions.

Airline operations economics is mainly driven by the logic, rules and algorithms of the OPS system used. The focus on resource optimisation meets the needs of today, but it will not do the job in times of artificial intelligence (AI), machine learning and big data.

Traditional cost-cutting programmes have reached their limits. The era of cutting the easiest costs is over. Successful airlines must understand and manage the granularity of their cost drivers to achieve further cost reductions. Airlines also need to understand cost deviations and what drives the changes per flight, as well as for the network (overall optimum).

Operations controllers need to have the cost of disruptions at hand, so that they can compare the merits of the action (steering activity) to be taken. This will be the most economic and passenger-satisfying option. Operations controllers also need to review the required time of arrival (RTA) and the cost index (CI) in real time, if the additional cost of higher aircraft speed (and so higher fuel consumption) is overall more economic than the cost of passengers missing flight connections. This requires exact costing.

Tomorrow's airline will predict, manage and control operations cost in the OCC. Post-flight OPS KPIs and cost control will be transformed into a pro-active task performed by the OCC.

With no real-time costing systems in place, airlines can choose to be innovators, early adopters or followers. Today, however, it is innovation that creates competitive advantages. Following the industry is not an option because changes will take time. They will require high data quality and different job profiles in the OCC. According to Peter Drucker, former management consultant, "the best way to predict the future is to create it."

This article provides insight into why airlines should consider investing in real-time costing to manage disruptions and irregular (IRREG) situations.

End of indicator-based costing

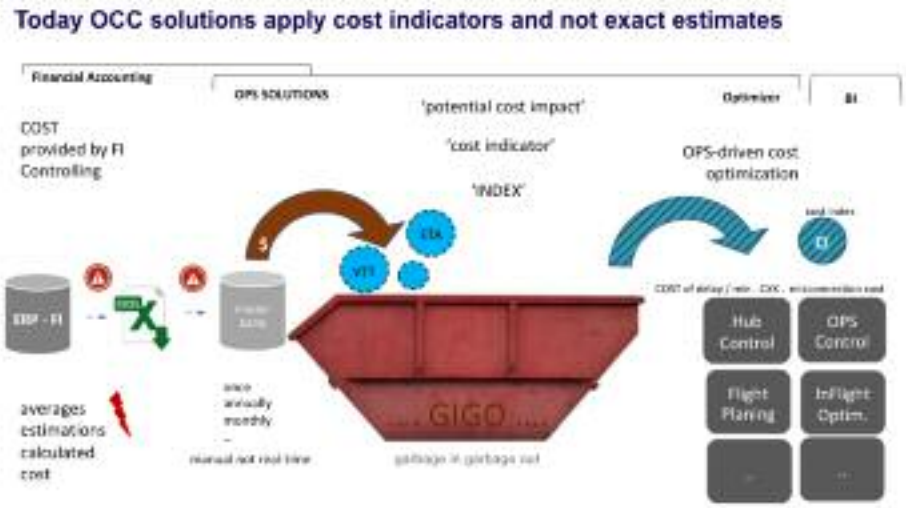
Over the past decade, leading-edge airlines have achieved significant OPS performance improvements by re-engineering processes via automation, and by detailing OPS IT optimisation solutions. Traditional cost-cutting programmes generated savings by outsourcing ground-handling (GRH), weight and balance (W&B), or flight planning (FPL). Airlines that have continuously applied cost-cutting and enhancements are lean. So what is next?

"The only way for airlines to learn how the different cost elements of their operations add up is to build a bottom-up view of unit costs, volumes, and productivity of their cost categories. This is a driver-based approach," say Steve Saxon and Mathieu Weber of McKinsey & Co, in 'A better approach to airline costs,' an article published in 2017.

A bottom-up approach for airline operating costs in the OCC will require that all costs are based on the number of units multiplied by the unit price. This makes cost deviations traceable and manageable. According to Saxon and Weber, "Driver-based cost analytics offers many traditional carriers the chance to cut costs by 10-20% per seat, even without a substantial shift in business models". This applies to airline operating costs.

As of today, exact driver-based costing is scarcely applied as part of real-time operations solutions. Vendors market 'indicator'-based costing tools in a world of real-time scenario management, situational awareness and big data analytics. Cost indicators are aggregated post-flight averages for disruption events (for example, cost per flight cancellation or cost per delay minute) provided by finance or financial controllers. The indicators are entered into the master data of the OPS solutions (which do not have bottom-up, real-time calculations), and the unit or standard prices are randomly updated. Adding to this imbalance of economic decision-making is that today's OPS optimisation is managed in numerous silo tools applied over the airline's flight profile, route network and ground operations.

Real-time economic decisions are mainly OPS/IT-optimisation driven. The question is, are cost indicators and OPS optimisation good enough, or do we need to know the exact cost of each individual disruption to perform better OCC/HCC decisions? The answer is straightforward: you can only manage what you measure. The cost, for example, of a flight cancellation therefore needs to be exactly calculated and updated when cost drivers



Airlines perform economic decision making in the OCC. Some do it with Excel others apply solutions which take cost into account as a master data input from Finance. Traditional costing is not designed, to feed these systems with exact costing, nor with cost details this translates into 'potential cost impact' economics. To avoid garbage in garbage out the cost drivers need to be exact as well (example variable taxi times VTT, ETA).

change, such as the number of passengers affected. The OPS controller needs to know the cost impact and the cost of steering activities to solve the issue.

OCC gut feeling, experience and estimates will not match what analytics can do. For example, the fuel savings produced per flight (210Kg per A380 flight) may be considered insignificant, but these small amounts can add up flight-by-flight to generate millions of dollars in savings per year.

Additional savings require in-depth analytics and IT through application of sophisticated fuel analytics solutions. Furthermore, according to a study of Switchfly, an e-commerce travel platform supporting airlines with re-bookings during heavily disrupted and irregular (IRREG) operations, IRREG operations cost US airlines at least $8.3 billion per year. With OPS (IT-based) optimisation getting smarter, precise costing is a prerequisite for harvesting peanuts, after the low-hanging fruit, or easiest costs to reduce, have been picked. So peanuts are worth going after. Driver-based cost analysis and management will allow airlines to save significantly. According to an article published by Airbus this year, Airbus' long-term aim for flight OPS data analytics is to reduce operational disruptions by 30%.

Reliable OPS data

OPS still has operational data and optimisation gaps to be closed before driver-based costing is viable. Today, flight management system (FMS)-based estimated times of arrival (ETAs) on blocks are not precise in some IRREG situations. An exact ETA is required for optimisation and costing. If the driver (ETA) is not exact (so-called 'garbage in'), then the impact or the resulting cost is not exact (so-called 'garbage out').

An example is calculation of the mis-connection cost. A 10-15 minute deviation in ETA may lead to a lost connection (so mis-connection costs will apply), a connection to be expedited (connection enabling costs will apply), while other connections may not be affected. Inaccurate ETAs translate into wrongly allocated steering actions made by the hub controllers, and so additional costs are incurred. More exact ETAs require a combination of analytics-based forecasting, FMS times and variable taxi times (VTT).

The HCC, on the other hand, needs to determine accurate variable gate-to-gate airport connection times, taking waiting times into account, instead of the currently used minimum connecting times (MCT). All cost and resource change drivers have to be taken into account to avoid causing passenger mis-connections because of long queues at immigration or security.

Airport collaborative decision-making (A-CDM) takes into account all airlines' operating situation. Today, A-CDM only manages departure times. But ETAs plus aircraft turnaround time determine the target off block time (TOBT) managed in the A-CDM process. Departure and arrival times, therefore, need to be managed by CDM. Furthermore, the status of all flights has to be openly shared to allow an airline to determine its individual operations optimum within an iteration process. A-CDM needs to be managed or evaluated in the OCC.

Weather-related delays

Weather accounts for costly and tangible disruptions. Weather-related flight cancellation and delay plans are difficult to manage with the current OPS solutions, especially when determining the most economic IRREG cancellation plan. Weather requires real-time reaction and preparation, since weather fronts can be better or worse than predicted.

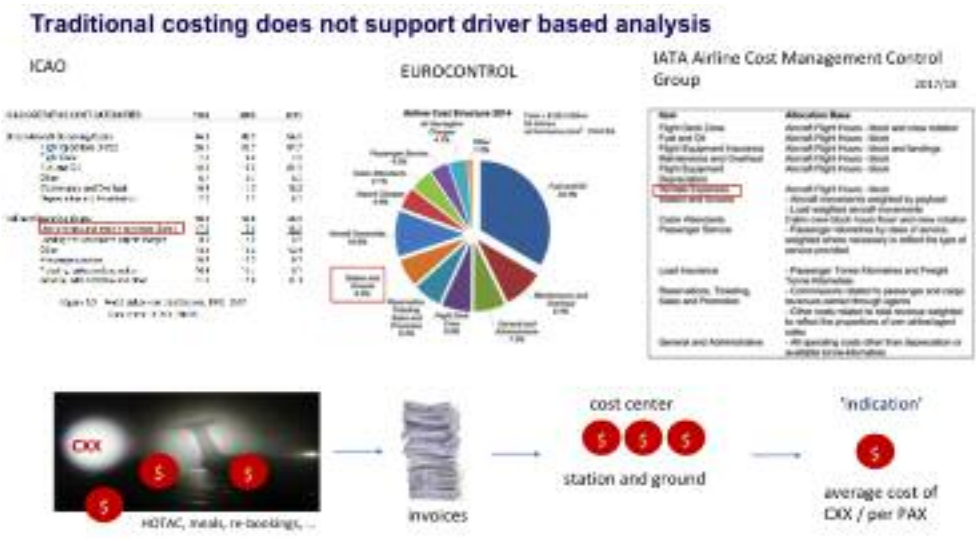
Knowing cost and impact will support the decision-making process. Air Services Australia has developed a meteorological collaborative decision-making (MET CDM) solution. Based on weather forecasts, the potential impact on the arrival/departure rates is predicted. MET CDM targets the optimisation of runway capacity in cooperation with all airlines. Cancellations are mutually agreed in a CDM iteration process.

Based on how arrival and departure rates are predicted to change with certain weather (compared to normal operations), airlines can predict the impact on operations and determine which flight cancellations are necessary to minimise delays and their impact on passengers. There is no HCC/OCC-CDM solution on the market, however, that compares economic scenarios. Cancellation plans are managed in standalone solutions developed by airlines to evaluate the most economic IRREG/cancellation plan individually. This is sub-optimal because airlines do not take other airlines' delays and actions into account.

Exact cost-driver data

OCCs need analytics and optimisers to efficiently manage the complexity of the situation, especially for heavy IRREG OPS. It needs real-time costing as part of impact predictions. Each weather scenario and each flight impact is different. Gut feeling and experience have their limits. Heavy IRREG situations reach a complexity that operations staff cannot manage. This is where real-time analytics platforms will make the difference. Exact cost and impact predictions will provide airlines with the full situational awareness and leverage to generate further savings by making economically viable decisions that ensure utmost customer satisfaction.

In terms of data quality and the detail required for cost drivers, even a single cost driver has a high complexity of changes to be taken into account for real-time decision support and predictions. Everybody knows the impact of rotation delays that account for a major share in delay reports (reactionary delay 5:46 minutes per flight, compared to airline delay responsibility of 3:34 minutes per flight according to Eurocontrol CODA Digest 2017). This situation is determined



Over decades airlines apply the same cost element categories for accounting. Leading institutions like IATA, ICAO as well as Eurocontrol apply common high level categories to benchmark airline cost. Traditional cost management has its limits when airlines need to perform economic decisions in the OCC. Accounting based cost element structures are not designed to provide an airline with an answer of how much a specific cancelation costs versus a delay.

by International Air Transport Authority (IATA) delay code DEL 93, which does not support analytics with reasoning. As long as DEL 93 is applied, analytics can hardly manage delays. However, airlines can apply their own internal codes to follow up the reasoning and actions taken related to reactionary delays, as well as the causes.

Today, more airlines keep passengers informed about disruptions. At the same time, airlines are tackling the soft cost of IRREG OPS. They relate a customer dissatisfaction cost to a delay. Airlines for America estimates that delays have cost passengers billions of dollars. Informed passengers are more relaxed, even when their journey is affected, and are more likely to fly again with the airline if they feel it is keeping them informed.

Delay cost, passenger satisfaction and steering activities to reduce delay have to be calculated in real-time for each flight. Every change in the situation will require a cost, resource, flight, network, turnaround and CDM optimisation update. A typical airline reactionary delay situation highlights data gaps to be closed (cost and exact time predictions).

The following example of a rotation delay indicates the data requirements (exact times) and changes needed to be taken into account for exact costing. Passengers are informed before boarding of an outstation delay, leading to a departure delay of 25 minutes). However, the aircraft arrives at the outstation 33 minutes late. In the end the departure to the hub where the flight has to connect with other flights is actually delayed by 36 minutes. On board, the cabin crew engages with passengers concerned about the connections they have to make at the hub, with no information in relation to their connection, 'we do not have a gate, but we will know the situation when we are about to land'. The ETA at the hub, to determine if connections are lost, is not reliable at the point when the aircraft is still on the ground, because too many variables can yet influence the eventual outcome.

ETA times and, therefore, connection optimisation, are most reliable when the delayed aircraft is about to land, and are calculated at 30 minutes and 10 minutes out. This is when the HCC starts taking steering activities for a flight. The aircraft takes off and with the movement (MVT) message, the first ETA is sent. In-flight, the flightdeck announces to passengers that they are flying at the highest speed and that they have requested short cuts. These have been approved, and the airport will provide a remote parking stand for the aircraft so that passengers can disembark faster via sets of two sets of steps. As a result, all flight connections will be met, and critical connections will be connected aircraft-to-aircraft via a ramp transfer, rather than by taking passengers through the terminal.

On approach to the hub, the flightdeck makes another announcement that, as a result of all the steering activities taken as described, the ETA will now translate into a 10-minute arrival delay, rather than the 36-minute delay originally announced. Gate-to-gate times have been checked, and all flight connections can be met. Passengers are advised to go straight to the gate so they make their connections.

Finally, gate changes are announced by the cabin crew. The aircraft lands and here the situation changes as the aircraft is guided to a ramp holding position. The position assigned is not ready because of the unexpected early arrival. The position is occupied by another aircraft. All the effort to reduce the delay (from 36 minutes to 10) has been for nothing, since previously satisfied passengers are now frustrated again, and have no idea if they can make their connections. The aircraft is parked (actual time of arrival (ATA) on blocks with a 27-minute delay because of a 17-minute taxi and parking delay.

This has come at a cost: the delay reduction cost efforts like OCC and HCC engagement (check of all connections, review of gate changes, expeditions, ramp transfer), and extra fuel burn to reduce the delay. With the delay not reduced, further costs apply due to extra block time and extra crew time. The RTA, which allowed the airline to meet all connections, was met by the flightdeck (reduced down to a 10-minute delay).

As a result, the airline managed to save the missed connection cost (re-booking, food and beverage and accommodation). In the situation described, it was the airport taxi in holding that turned the flight into one with connections lost, with mis-connection cost applicable.

Airlines need to take care of misconnected passengers. Passenger rights websites provide calculation tools about what stranded passengers can claim. In the example above, however, it was not the airline that was at fault. The position assigned to the aircraft was not available.

Airlines that are able to document these costs and assign delay ownership should be able to transfer the cost to the appropriate party. Airlines have service level agreements (SLAs) with suppliers, supplemented by a penalty payback programme. No-one, however, assigns the cost of the passenger misconnections to the party responsible. Airlines have negotiated their SLAs in such a manner that they get reimbursed by their suppliers, if these caused a delay. In the example of the aircraft being assigned to a remote taxi holding position, the passenger misconnection-costs are surely much higher than the reimbursement agreed in the SLA.

The truth is that cost indications will not do the job in this case. Savings and penalties require the calculation of the exact cost of a delay, the delay drivers, and responsible party. Airlines that know these costs and drivers will make much better economic decisions, and can share the burden with the delay-causing party. Sharing will also generate incentives, with all parties working jointly on the most economic and passenger-satisfying outcome. Economic decision-making requires reliable cost-driver parameters applied to the costing.

Apart from fault cost assignment,

costs need to be more detailed. Airlines for America calculated the average cost of delay for US passenger airlines in 2017 at $68.48 per minute. In the example above, this translates into a delay cost of $1,849. This amount does not cover the cost of the 27-minute delay if the airline has a high number of lost connections. Large network carriers have an average passenger connection share of plus or minus 60%. With 60 connections missed at the end of the day, $30 will not pay for accommodation and rebooking, so point-to-point operators have a different delay cost than network carriers taking care of connections.

Today carriers struggle with data quality for analytics. A European carrier's comments illustrate this issue: "Our post-flight data quality needs about three weeks to reach a quality level higher than 90%. We have too many standalone data sources with different values and we have different suppliers involved. This means that on top of our internal data issues, we face further data deviations when comparing supplier data sources with ours".

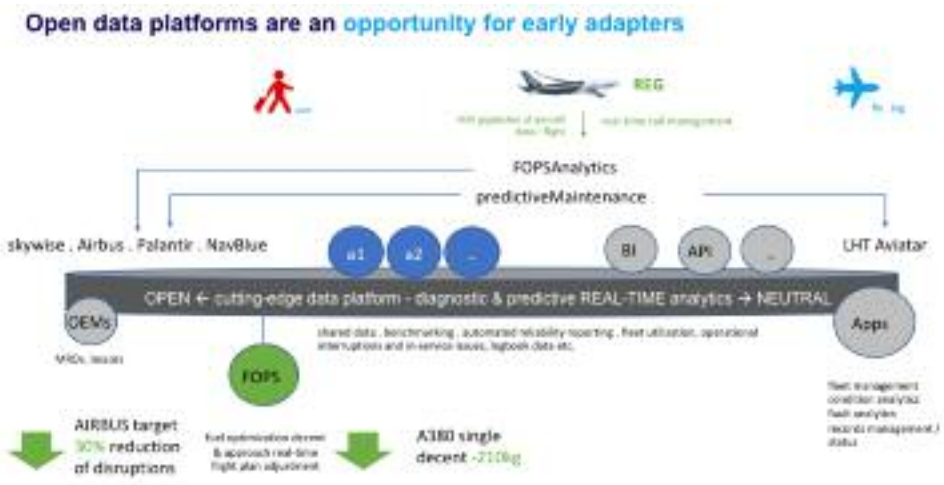
Operations cost errors

Are costing solutions far off into the future? No. Airline operations cost-management tools exist. The missing link to OCC costing is a powerful real-time cost calculation and analytics engine. Today's costing solutions are post-flight calculations, with no real-time requirement. The calculated airline operations costs are compared with the invoiced cost, and they can take as long as they want to make the comparison. The algorithms and data required for invoice control and real-time costing, however, are the same. IATA assumes saving potentials of up to 2% of the invoiced cost. A major share of the invoice versus actual cost deviations are cost-driver (operations data) deviations. The airline and suppliers relate to different operations data (different sources and quality). Data quality and data accessibility is key for invoice control as well as real-time savings. A commonly agreed and applied data source would empower real-time analytics and would reduce invoice control efforts. Data deviations should be managed within the OCC/HCC time frame, not in the following weeks or months.

Within the limited frame of costing applied in OPS, there are more obvious data quality issues to be addressed before economics in OCC can take off. Airlines worldwide apply CI, which is a simple ratio between cost of time and cost of fuel. That is, higher aircraft speeds will reduce flight times and so reduce time-related costs, but will increase fuel consumption. The CI is intended to provide flight crews and operations departments with a relationship between aircraft speed, fuel burn and cost, and time-related operating costs.

The data quality determining the CI, however, is in many cases questionable. "The biggest error in calculating CI values undoubtedly comes from miscalculating operating and time-related costs," says Holly Edwards, PhD, researcher at the University of Leeds, in her study on CI. The difficulty is in determining all the different costs for the equation. "No overall solution can be provided to the industry because each airline has different cost structures," says Edwards.

Vendors using CI for their applications turn a blind eye to CI input data. They know that some airlines determine an annual corporate CI or a fleet CI, instead of calculating an individual CI for each flight. "This is unlikely to be resolved until airlines' flight operations and financial departments cooperate with each other," says Edwards. Every airline not applying a real-time calculated CI for each individual flight loses money, because the cost base for speed versus time cost does not take correct cost (averages, estimates)



Data analytics take shape. Lufthansa Technik (LHT) and Airbus have invested in data analytics to manage mainly maintenance relevant big data. These open data platforms are designed to apply neutralized data from all participants openly sharing the results benefiting all. Open data platforms provide highly sophisticated analytics solutions for all. This model is also an opportunity for Flight Operations.

as well as cost drivers (for example, individual aircraft performance, misconnected passengers) into account. That is, the CI used is too basic to be of any real use.

If there were reliable OPS cost drivers in place, then the missing link to assure full scope economic decision making, in the OCC/HCC's performance optimisation landscape, is real-time customer impact and cost data. By applying real-time customer impact and cost data, airlines need to change the way they manage costs. It requires re-engineering of costings and cost management. The traditional account-based average calculation provided by finance will be replaced by activity-based costing (ABC). Cost driver-based costing, or ABC, will be performed automatically. This is the use of IT systems to calculate actual costs for the particular flight in real-time. With every significant situation change, the impact and action options/cost will be provided for the OCC controller to take the most economic, safe and customer-friendly option. Real-time costing requires exact inputs and reliable predictions.

ABC on the rise

As of today, costs are gathered and controlled in the traditional way of post-flight by invoice and financial controllers based on operations data received. This takes place weeks or months after the event took place. The focus of the traditional system is to assure the use of correct costing for accounting and payment purposes. For example, the quantity of meal vouchers give to passengers as part of the cost for a delayed flight.

In this system, finance does not determine if a different operations scenario would have been cheaper, and what actions need to be taken to improve the decision-making in the OCC or HCC in terms of passenger satisfaction and cost.

With the monthly accounting closure, when correct costs are determined and posted into cost centeres, it is the financial controller who calculates the average cost for certain operations events, such as delay cost per minute, and cost of a cancellation. This is then deployed as average master data in an OPS system. Airline operations costing and cost control is performed in alignment with the requirements of financial accounting (cost centres, cost elements, monthly closures, statements, accruals and predictions). This makes it hard to dig into deviations and to determine the actual cost and cost drivers.

The airline cost management group (ACMG) of IATA carriers has developed its own methods of expense allocation to aircraft types by function or expense item. Members that cannot allocate the airport charges, aircraft-related charges, airport-related passenger charges, and air navigation charges to individual flights should contact the IATA ACMG secretariat for guidance.

This clearly indicates that cost allocation based on traditional accounting methods is rigid, with a clear focus on cost centre controlling department structures. It is not based on cost drivers. The airline knows what was spent on average per month for a number of stranded passengers in terms of accommodation and meals provided. Delay costs are calculated in the same manner by aggregating average cost related to a delay. This is all that is available.

Airline operations costs have been accounted and managed in the same way over decades. While the industry is becoming digitalised and agile, costs are compiled and compared in the same way without any change from 2017 (ICAO) to IATA (2018).

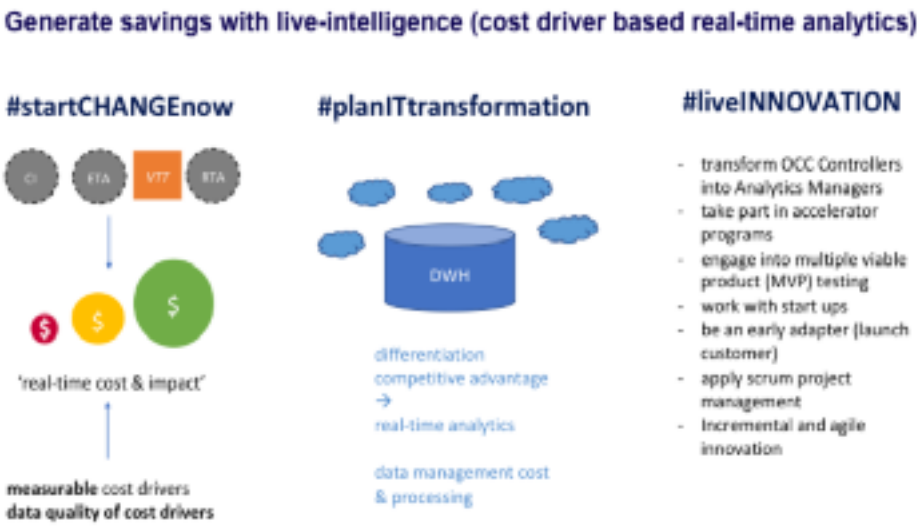
Individual airlines and institutions, such as Airlines for America, calculate average cost of delay based on traditional cost accounting categories. For US passenger airlines in 2017, Airlines for America calculated the cost of delay at $68.48 per minute, mainly taking into account crew, fuel and maintenance costs.

In the same context, Airlines for America indicates that there are further costs related to delays that are not covered by traditional costing, of several billions of dollars in 2017 for all delays. When taking passenger perspective into account, Airlines for America estimates $49 per hour as the average value of a passenger's time. The Federal Aviation Administration (FAA)/Nextor estimated the annual cost of delays (direct cost to airlines and passengers, lost demand, and indirect costs) in 2017 to be $26.6 billion for US airlines.

By taking the soft costs (social media and brand image) of a delay into account, airlines can better manage passenger relations and economics. Some airlines already take passenger value into account to determine if a steering activity (to enable a passenger to catch a connecting flight) is economic. These airlines rank passenger value according to class and frequent flyer status. These rankings, however, are rough estimates compared to exact costing. As soon as airline operations passenger goodwill and value, and costs are detailed, more complex scenario comparisons can be performed. All value and cost drivers can be taken into account at the time of the event, and it is better if certain situations, such as delays due to fog, can be predicted. Based on the scenario comparison, the most economic way for ground steering activities, aircraft changes, and dealing with delays and/or cancellations can be evaluated. The disruption cost categories to be taken into account are summarised.

Real-time airline operations costing scenarios are complex due to the number of events and cost-driver data required to be calculated in real time. To manage this complexity, software and hardware are required that can perform real-time calculations.

Until now, this was a costly investment, with no business case having proved a return on investment. This has changed. Hong Kong Airlines is developing a new data analytics tool with Skywise and NavBlue, both Airbus



With traditional cost cutting programmes reaching their limits, airlines need to reach out to cost-driver based analytics to generate competitive advantages. Data analytics need exact data. Common data management obstacles like data duplications, questionable data sources and fragmented or not measurable data sources all have to be fixed. This is a time-consuming effort all airlines will face.

companies, to automatically adjust the flight management system's flight plan to fit the aircraft's performance in real time, with the target of saving fuel.

It is just a matter of time, therefore, for an early adapting/innovative airline to apply OCC economic decision-making to manage IRREGs. The ground work is there. Many of the IRREG cost-driving parameters are based on measurable contracts, such as cost per hour for parking. Flight compensation regulations (cost per passenger for delay, cancellation or denied boarding for specified flights and situations), and items such as ramp transfer bus orders can be calculated accurately based on cost of the action applied to passenger and connection flow.

When the situation is calculated, different OPS scenarios can be compared in terms of passenger impact and cost. With a costing model connected to a resource optimiser, different cost/resource OPS scenarios can be compared and the most economic decision can be calculated, based on the best mix of actions from an RTA request to the flightdeck (the aircraft flies faster, burns more fuel, but mis-connection costs are reduced) up to gate changes (passenger connection time is reduced), among other steering activities.

Cracking traditional average costing is pioneering for OPS and Finance. It requires additional work on getting all cost-drivers exact and measurable, but airlines see value in a measurable approach. "There are a number of costs we cannot control today, since neither we nor our suppliers can measure the quantities. Our target is to make all cost measurable from contract to invoice on an item-by-item basis," says a purchasing and contracts manager at a European cargo airline. This means airlines move to fully transparent and measurable costing for airline operations, as well as warehousing and pallet build-up cost.

Bad weather management

Managing bad weather situations based on analytics and forecasting requires a reliable OPS impact database to determine a sustainable IRREG OPS plan. Determining the impact is the next step from situational awareness towards predictive analytics. With predictive maintenance solutions taking shape (Skywise/Airbus and Aviatar/Lufthansa Technik) and MET-CDM analytics in place, it will be possible to cost weather disruptions and maintenance events. This is especially in the case of MET-CDM, when airlines align cancellation plans for bad weather/heavy IRREG OPS with the airport in an iteration process. It is necessary to evaluate the real-time value of a flight (revenue, passenger relations), as well as the exact cost of the cancellation or a delay impact, so that the most economic state possible for all parties involved can be reached.

With exact OPS data (for example, ETA times) in place and with reliable MET forecasts, the cost drivers will calculate sophisticated cost scenarios with full situational awareness at hand (based on the cost models determined). The costing model would need to take care of the quantity of each resource multiplied by the unit cost by taking contract master data and complex costing algorithms into account. The relevant costing models already exist (invoice control solutions); it is just a matter of transferring them into real-time mode.

Applying airline operations costing in real time is a win-win situation as contracts and invoices are controlled on the same costing and algorithm basis. Moreover, apart from operations costs, airlines could manage lease cost, OPS impact on leases and contracts within the same cost model framework in place. The only difference is that OCC costs are flight-based, whereas aircraft lease and maintenance costs, as well as lease conditions, need to be aircraft-based. As a result, the cost of the fleet will be the controller's responsibility, so they will not only manage disruptions economically, but also the lease conditions and costing in real time.

Real-time costing

Innovations originate from necessity, and today's lean airlines fulfil the prerequisites to apply real-time costing. With operations optimisation at the point where all leverages have been pulled, the next logical step is real-time costing. This is on the verge of materialisation.

Some airlines are becoming more actively involved in innovations to determine competitive advantage. Boston Consulting Group and KLM Dutch Airlines have joined forces this year to develop an artificial intelligence solution for costing, operational performance and customer satisfaction. Others engage with start-ups via accelerator programmes and apply multiple viable products. Leading airlines run agile incremental projects. Real-time costing and analytics is an important innovation topic.

Costing in OPS control

Many OPS control solutions do not support cost-based decisions. The ones considering cost, for example, NetLine/Ops ++ MoneyMachine, take real-time cost indicators for typical operations control situations, such as flight delays, cancellations or equipment changes on scheduled flights, into account. In combination with randomly fed data, however, costing may turn into an estimate or rule-of-thumb decision, depending on how significant the 'garbage in' data feed turns the output into 'garbage out'. Some airlines perform cost master data updates once with the implementation of the tool, while others take averages into account that are published by institutions like Eurocontrol or based on the data published in FAA DoT Form 41.

Airline operating costs are extremely individual (fuel prices, ownership and crew salaries). Even costs, such as parking fees, differ by time of operations. Managers need to manage not only the

schedule, but also the cost of the schedule. Lufthansa Systems' NetLine/Ops ++ MoneyMachine manages the comparison per flight and schedule.

Costing in flight planning

Sophisticated flight planning systems come very close to real-time costing. Solutions, such as Lido 4D from Lufthansa Systems or Flight Keys' 5D trajectory optimising solutions, compare different flight/route scenarios based on overflight routing and fuel consumption, and determine different costs and flying times per route.

Accurate detailed cost driver-based costing and comparisons pay off for flight planning, but this is not where it ends. Airlines have evolved flight planning to real-time in-flight mission support. As mentioned, Hong Kong Airlines works on in-flight plan optimisation with Airbus Skywise and NavBlue.

On average, the original flight plan (OFP) is issued three to six hours before the flight. For decades the OFP was filed and not touched after briefing, but airlines have now outsourced automated flight planning. They manage the in-flight real-time updates of the flight profile in the OCC when significant deviations occur. These are items such as weather, NOTAMs, and mis-connections. This allows proactive, real-time route or flight plan optimisation. At the same time CI, fuel statistics and short cuts are added to the briefing package based on analytics.

Inflight optimisation

Airlines also apply in-flight optimisation solutions to determine cost-efficient speeds and altitudes in the cockpit in real time to react to unforeseen changes and opportunities, taking passenger connections and cost of fuel burn into account. Honeywell and PACE TXT provide sophisticated solutions that take into account the latest weather updates with the latest ATC information received in the cockpit. Hong Kong Airlines is working on an in-flight plan optimisation solution with Airbus Skywise and NavBlue.

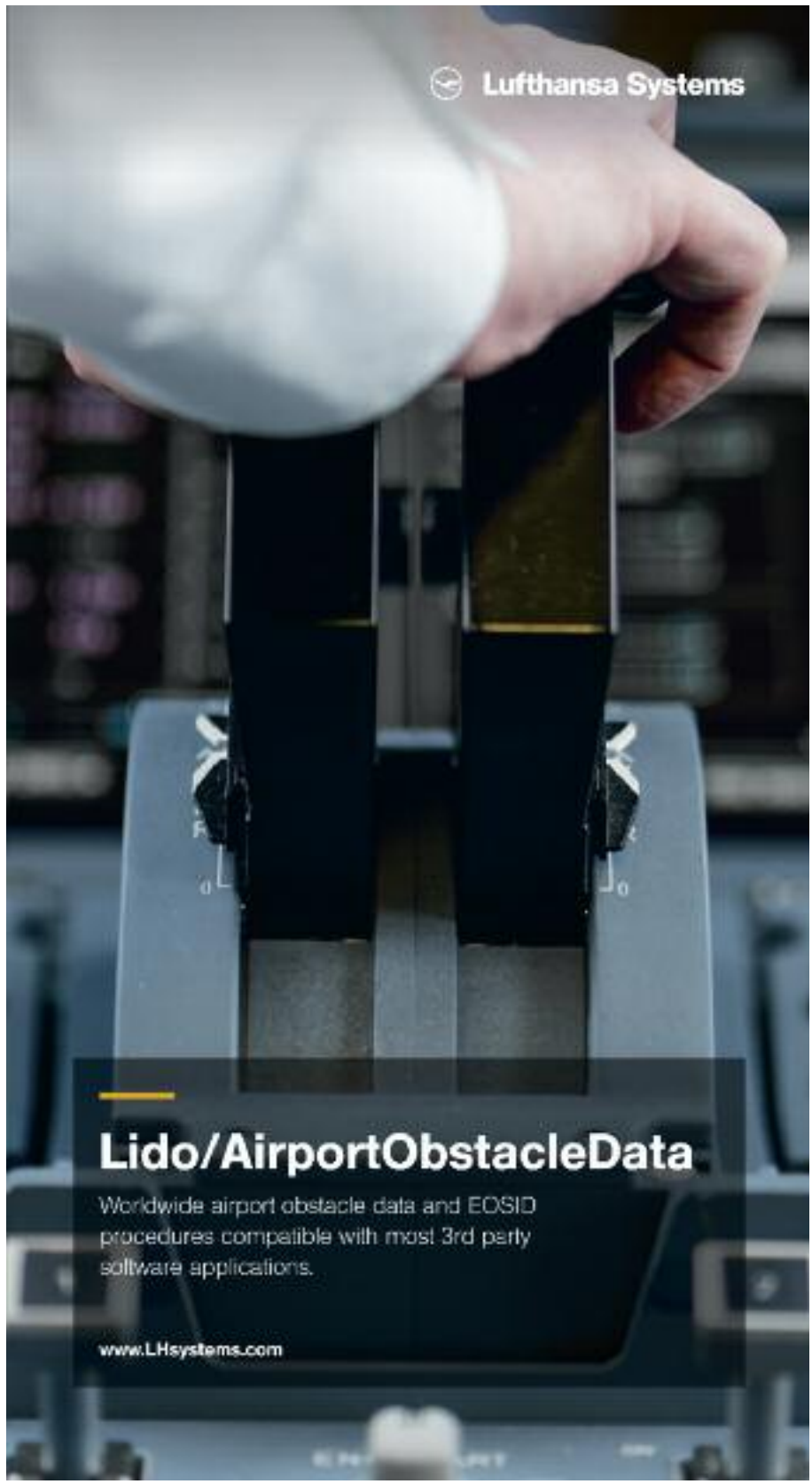
HCC for connections

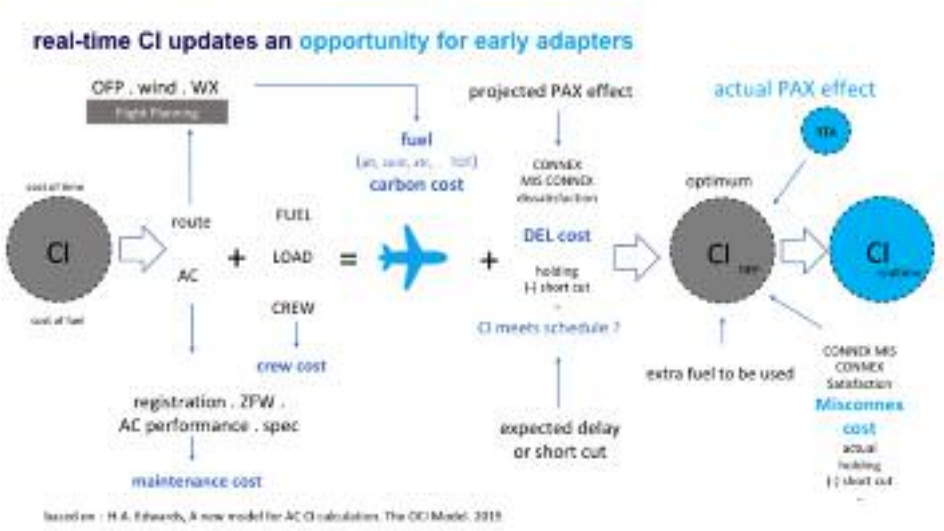
HCC solutions, such as NetLine/Hub from Lufthansa Systems, take into account mis-connection cost and passenger value when ranking passenger connection flows of the hub (based on number of affected passengers). In case of mis-connections caused by inbound delays the HCC is alerted to manage the situation. Based on a cost index the most economic decision is indicated.

Inflight speed changes are related to saving connections, since mis-connections have a cost. At leading hubs, the saved connections and savings are displayed as KPIs. Hub airlines not only move passenger connection and turnaround management closer to operations control, but also integrate the systems in place. There are hub connection management and turnaround solutions with no interface to operations control solutions. Ranking the passengers most valuable to be saved and the steering activities that the passenger connection manager can apply (for example, ramp transfer or expedition) is performed manually, while decisions are shared and agreed verbally, with no overall optimisation analytics solution in place.

Automated real-time costing

Invoice control solutions have been described *(see Maximising efficiencies - key cost and operational considerations for airlines, Aircraft Commerce,*





Numerous flight planning and inflight optimization solutions apply cost index (CI). As of today numerous airlines do not apply CI correctly. The CI is to be calculated for each individual flight /aircraft with exact costing and cost driver data (e.g. cost for fuel) to determine the optimal CI. Taking CI one step further delays need to take the required time of arrival (RTA) and passenger misconnection cost into account.

December 2017/January 2018, page 28). The systems of XLM Aero and Sabre Airpas calculate accurate cost per flight. This is based on OPS cost-driver quantities, cost per item based on the contracts, and parameters post-flight.

Barcelona-based startup Airplane Solutions was granted €2.2 million from the European Union's H2020 innovation programme to develop a hardware installation on aircraft, designed to share the operations cost drivers with a cloud until 2020. The raw operational data is used to calculate the different cost categories item-by-item in real time for invoice control. In addition, aircraft data will assist in lease and fleet management.

The leverage and evolution paths of these different silo solutions related to costing are getting closer to real-time IRREG OPS costing for operations. With the H2020 initiative, the gap will be closed within the next five years. For accurate real-time calculations, all variables need to be taken into account, including drivers, such as weather and CDM parameters affecting cost, operations and passenger satisfaction.

Driving tomorrow's change

Application of situational awareness management systems for OCC and HCC, as well as related reporting, can be determined as a generally applied industry standard. BI and analytics implementation are in progress. Eight out of 10 airlines are looking for data analysts and 'business change analysts'. American Airlines searches for business analysts 'to deliver high-quality data solutions, as well as real-time decision systems used by the operation'.

With BI and post-flight operations, airlines that have implemented data analytics position themselves at the frontier where industry standard faces innovation. This is where cost-driver-based costing needs to be taken into the equation, and cost indications are not good enough anymore. Leading lean airlines once again need to identify new cost-saving and performance possibilities.

Predictive systems already exist, such as predictive maintenance and weather impact forecasts. Until OPS data is holistically and frictionlessly taken into account, complemented by cost and customer-service data, there are still potential savings to be realised. Exact OPS cost driver and costing is required for airlines entering the phase of prescriptive analytics. This is where action scenarios or steering activities are compared and validated to provide controllers with the best economic alternatives.

Airlines have to decide how they want to manage economics five years from now, and how they will achieve this. Significant competitive advantage is not generated by followers or the industry standard. Followers can avoid certain pitfalls by acquiring tested products, but using them efficiently requires culture and organisation change, which takes time and can require different skill sets. So leadership and competitive advantage are correlated with continuous change, data analytics and transformation of capabilities within the organisation. This is why airlines hire transformation and change managers.

Airlines need to determine data sources, data quality and cost-drivers now, to be ready for the change. Airlines need to determine requirements and find an off-the-shelf solution that fits or a startup designing it.

Recently, more influencers are running agile projects and opting for open incremental innovation. Airbus Skywise, as well as Lufthansa Technik with Aviatar, provide open neutral data analytics platforms. Mainly applied for preventative maintenance and aircraft performance analytics, airlines share neutralised data for benchmarking. Airlines applying agile and incremental methods are ready to deploy innovation without risk of failure. These methods move project targets in small achieveable steps based on existing products.

Pioneering developments in savings and competitive advantage come with open idea-gathering and placement, multiple viable products, innovation alliances, accelerators and startups. Innovation also has become a core driver of growth and performance for the aviation industry. Technical innovative leadership pays off and positively influences an airline's image and brand. 'Le Garage', the Airbus innovation hub, was established in 2017, while Lufthansa founded its own innovation laboratory the 'LH Innovation Hub' in 2014.

There is a variety of different approaches in place. More airlines cross the launch customer border and apply accelerator programmes. This means they invite startup companies to provide them with a plausible idea, a blueprint of how a competitive advantage could be achieved in areas where they intend to differentiate themselves, or see potential competitive advantages.

With the Qantas accelerator programme, AVRO participants can receive up to A$150,000. IAG Hangar 51 modules, with one being 'smarter operations', where the philosophy is: 'by connecting systems and data across our operations, we believe that we can create optimisation insights that will increase the service and value we offer to our customers. We want to work with companies, making breakthroughs in disruption management, baggage, decision support and punctuality through the use of big data analytics, robotic process automation, baggage robotics, autonomous vehicles, smart contracting, natural language processing, and sentiment analysis'. This is where real-time costing fits in, but it is an idea that has not been deployed holistically in an OPS solution.

The next series describes how cost-driver-based costing can be applied, as well as the background of activity-based costing (series part 2), followed by airline / vendor interviews and costing benchmarks (series part 3). AC