Airline operational management has relied on interacting with a range of non-connected tools and systems handled by a number of different departments. Sander de Moor, Director Airline Operational Efficiency with Aircraft Commerce Consulting, takes an in-depth look at how airline operations may benefit from digitisation,.

Airline digitisation: onboard & centralised IT tools in operations

The move towards a more data-driven culture is generally agreed to deliver significant benefits to airlines, in terms of improved efficiency, safety and profitability, and to their customers that have more streamlined, personalised user experiences. The scope of digital transformation is huge, and extends far beyond airlines to effectively span the entire flight ecosystem. Stakeholders range from those building and maintaining the ecosystem to those filling, regulating and using it.

While digital transformation may have the largest impact in, and will most likely be driven by, transforming the commercial areas of the business (such as the approach to passenger and load data management and interactivity), this article discusses how digital transformation impacts and benefits the flight operations environment.

Information management

In a traditional airline environment, a range of IT systems is used to manage diverse processes and roles in areas, such as maintenance & engineering, flight operations, flight dispatch, performance engineering, commercial operations, and others. IT systems are not often designed to communicate with other tools, and may show a certain vintage in architecture and usability. The procurement cycles of these tools and systems have a life on their own, and are more or less aligned with the silos and departments within the airline. Each department uses a mix of department-only systems and tools, and tools with a wider application and user base. A local database or Excel sheet is often used for reporting or tracking, and is partly populated by operational data from aircraft technical logs or the operational control software, or both, while the resulting data sits locally with the department and is not shared with others in the airline. Usually the location of operational data is determined by its use for a specific reporting stream. That usage is based on ‘we have always done things this way’, which can then be traced back to an individual who ‘set things up back when’. This is a case of empires within an empire.

Most airlines have developed an operations control centre (OCC), staffed by a range of sector specialists to help keep a published flying programme on track. Some OCCs have developed into integrated OCCs (iOCCs) with larger spaces housing more people, sometimes at the expense of the entire system. Communication is often the weak link and is not keeping up with technology. As part of its remit, the OCC is usually tasked with maintaining the operational control software data, to ensure a ‘single truth’ with respect to the performed flying programme in terms of: flights performed; their operational times: ‘Out’, ‘Off’, ‘On’, and ‘In’ times (OOOI); flight details of note; occurred diversions; and the all-important on-time performance (OTP). It is up to the OCC to decide on this single truth, because it relates to the OOOI times, and various ‘truths’ are reported by different stakeholders. Station management reports on-time departures from a gate or parking position, with a subsequent long taxi-time; flight crew have their own interest in reporting OOOI times on the tech log in relation to their contracts; air traffic control (ATC) will report OOOI times to suit its reporting streams; and finally the aircraft itself tracks everything operational based on time data received from the navigational equipment. Last, there is the on-board clock.

Business intelligence

When an airline decides to upgrade its operational data management to get a better grip on collecting and analysing its many layers of data, and takes the recommended step of implementing a business intelligence (BI) tool, one of the first issues that comes up is that the various reporting streams show different times for the same events when these streams are brought together. Obviously, a single truth exists, and it needs to be propagated throughout the airline to those using this data in their reporting.

The next step is deciding which dataset holds that single truth, by cleansing and evaluating the data collected from various sources. And the more sources the better, since on the one hand more same-data from more sources creates a feedback loop for erroneous data in more sources. In turn these steer the actual reporting accuracy, and on the other hand it ensures a larger chance of finding the truth in more same-data sets.

Another issue that soon arises is the many weaknesses of manual reporting streams. The aircraft technical log often shows erroneous or illegible data in recorded OOOI times, and fuel-related numbers and calculations that are then

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transferred into various record keeping systems. These are never corrected. Manually produced movement messages (MVT) can show typing errors that, unless significantly wrong, are often only found by chance. It is the OCC Operations Controllers that usually have the task of deciding on a form of the single truth by cleaning the system data.

Provided that automated data is produced correctly, and is flagged when it is outside expected parameters, it avoids the pitfalls of manually produced data. Current fuel management information systems (FMIS) are good at these data management processes, and are a BI tool for managing flight operational data and in-depth fuel efficiency (FE) analysis.

Having taken initial steps in engine and system health monitoring, today's aircraft have evolved into true data warehouses, producing terabytes of quality data from a wide range of sensors and systems. Some is stored and managed on-board for later transfer, while other data is transmitted either at programmed times or on-condition using the legacy aircraft communications and reporting system (ACARS) or more modern satcom-based solutions. The key is that transmitted data should serve a real-time purpose or not be sent at all. In addition, not all significant data is captured or used once transferred. There is a raft of reasons for this, including social (union) issues, failure to understand the concept, lack of urgency, or simply a lack of vision on digital adoption and operational data management. The result is that airlines are not taking full advantage of the potential their new, expensive fleets offer for managing operational data.

The connected aircraft

A report by satellite market research specialist Euroconsult states that in 2017 about 7,400 commercial aircraft were equipped with external connectivity for the passenger cabin, and that this number is expected to increase to 23,000 by 2027. This will improve the passenger experience, driven by such factors as projected increased bandwidth and lower unit costs through equipment upgrades and fierce competition. Video streaming may even become standard.

All of this is good news because the projected connectivity of the global fleet of commercial aircraft will drive and allow cockpit and aircraft connectivity as well. Connected electronic flight bag (EFB) applications already offer real-time updates of operational information, as well as in-flight updates of relevant flight information along the planned flight track (graphical weather data, traffic information), enhanced flight crew situational awareness and pro-activity in flight optimisation management and efficiency. It is also enhancing communications with ATC and the airline's OCC, and air-to-ground real-time information transfer.

The vastly enhanced capabilities to exchange flight, operational and other data in real time offer improved flight safety, flight efficiency and customer service. The aircraft can transfer or accept more and more detailed data to and from its systems, and leverage it by using new EFB-based tools that help optimise flight efficiency. It can also become a more integrated part of an extended enterprise connected network (a node). This means the aircraft will play a more significant role in data gathering and distribution, both operationally and commercially. This is a good thing, provided that airlines equip themselves with the tools necessary to make full use of the increased capabilities on offer.

As described earlier, a key issue faced by most airlines is the enduring presence of legacy systems. For large, multi-national businesses such as airlines, a complete overhaul of operational systems is a challenge, but a necessary one if they want to survive. In a recent panel discussion, Emirates' Tim Clark stated that: "Our business has to move at the pace of customer expectations. If our business cannot keep up it will perish." Transformation of tools and processes (technology and platforms) is key to future-proofing front- and back-end systems, and is connected to the transformation of the airline's commercial systems and processes. Including operational architecture in the scope of change will accelerate an airline's move to the next digital level.

Working smarter - OCC

If recent history is any indication, developments in enterprise systems will move more towards a cloud-based (off-site) modular architecture with unprecedented levels of inter-connectivity and intelligence. There will be an erosion of the classic distinctions between core systems, such as reservations, departure control, weight & balance, operations control, flight planning, flight watch, maintenance planning, and crew planning. This will lead to a super-architecture incorporating all the functionalities of these core systems, while internally interacting with a single data warehouse and a single truth. This super-architecture will use machine learning and artificial intelligence (AI) to 'connect the dots and discover new dots', so that next-level versions of these concepts work together in a network that includes all the airline's operational assets, and is also connected to the networks of external stakeholders in the flight ecosystem (air traffic management, airports and others not yet thought of).

In a future OCC concept, a handful of operations managers maintains complete network situational awareness. The day-of-ops is run automatically by a form of

Once an aircraft has been assigned a flight, it runs and calculates its own flightplan and fuel requirement based on detailed input directly requested and received from airline, ATM and airport networks.

AI following robust parameters, inputs and information management routines. Complete and actionable information will be available to all stakeholders and beyond at any time. This automation saves time in collecting, evaluating and propagating data. It will find a best fit and much more complete solutions to, for example, network disruptions through its capabilities in considering a lot more input compared to human handling.

Disruptions will still happen. Changes in the execution of the Network Plan, the daily flying plan, caused by disruptions are identified and analysed. Impacts are assessed through simulation, using predictive analytics tools to quickly present possible solutions or pre-emptive amendments, enabling faster decision-making. The role of the operations manager will be to monitor inputs and manage operations by exception when results of disruptions fall outside set parameters. Stakeholders are virtually in touch with each other using collaborative tools, while complete and accurate information is available transparently to everyone. The range of internal departments that can be integrated is much higher and can include external stakeholders like ATC, airports and weather service providers. The number of stakeholders can be increased, while the number of staff required to be physically present in the OCC can be reduced.

Much like a modern cockpit, a future OCC must be focused on handling the exceptions: those cases where the impact of a corrective solution falls outside set parameters. The majority of OCC functions will be running in the background, managing small disruptions and tweaks as the system becomes aware of them. OCC management monitors the performance of the automation and the resulting network efficiency, and guides or takes control in cases where deemed necessary or prudent. Previous slow-downs in hierarchies, procedures and communications have either been automated or given a different path. Analysed data to support optimised decision-making is directly applied. Data-driven scenarios are developed, evaluated and executed much faster than is currently the case. The prerequisites for such a set-up are:

1. Information integration: All relevant data must be available in the IOCC in a useful form (on-demand and visible when relevant). A single reliable and consistent source of truth must exist across the airline, and be used for basing all decisions. Driven by robust data-collection and -verification algorithms, the airline's OCC system integrates all information feeds, consolidating information into user-friendly output.

2. Process automation: Routine, describable tasks and detailed automated monitoring, such as assigning stands to aircraft, flight planning, communicating with cabin crew and flight crew (through chatbots), controlling aircraft turnarounds in a role-play-based environment, can all be removed from the controllers, allowing operations to be monitored at a higher level with fewer people. Analytical tools will predict disruptions and offer solutions with impact analysis by simulating the various scenarios. The aim is to save time, improve operational performance and reduce the number of people needed to manage these processes.

3. Virtualisation and situational awareness: Airline operations are always likely to be run from a centralised entity, but the size, use and location will change. In today's connected world, OCC team members do not need to be in the same room, or even on the same continent, to effectively work together. International teams have successfully shown the advantages of integrating pools of knowledge in a networked environment. The OCC may become a virtual meeting room without a physical presence. Flight dispatch, crew control, operations control, maintenance control and others involved in the decision-making processes can work virtually together in whatever form these departments exist. Automation will make a number of these functions obsolete and staff doing their (changed) work can do so from any location, logged on to the virtual OCC and relevant system(s) with 100% situational awareness dedicated to their area of expertise or activity, and an understanding of what is happening or about to happen in the network.

For an airline considering a version of this model to manage network operations, the following could play a deciding role:

- Better input: The ability to leverage more know-how from more stakeholders simultaneously, aided by automatically receiving vastly more input than has been the case before, more complete and also much faster.
- Better output: Optimised, tailored operational decisions based on more complete and intelligent business analytics will drive transparency and efficiency. Decision-making will be based on solid data, avoiding ambiguity about source, truth and value of information.
- Cost Efficiency: Automation will allow the same small number of core staff to manage an increasingly complex network.

Working smarter - aircraft

One such asset in the network would be the local network (brain) on board an aircraft intelligently managing all aspects of operating the aircraft from power-on

Air Navigation Service Providers (ANSPs) take the lead in creating time-based operations with the aim of establishing precise on-waypoint operations, which facilitate more efficient arrival sequences and avoid holding delays at busy airports.

to power-off. Again, with respect to operational functions only, once an aircraft has been assigned a flight, it checks in with the airline central entity for all relevant mission details and then runs and calculates its own flightplan and fuel requirement based on detailed input directly requested and received from airline, ATM and airport networks. All other processes related to flight preparation (load planning, cabin planning and preparation, catering planning, water/waste service, and fuelling) happen in a similarly automated fashion, enabled by Internet of Things (IoT) applications on all removable items on the aircraft. The intelligence on the aircraft runs it all in much the same way as was previously done by humans. The airline central entity keeps an eye on things, checks for quality, and updates mission profiles as and when required in a continuous process.

Key in this concept is that each intelligent node forming part of this ecosystem contacts other nodes, networks and entities autonomously and directly. Each intelligent node, therefore, pulls the information to function, and pushes processed information from sensors and systems in both traditional data streams related to health monitoring, performance monitoring, flight watch and other functions, and distributes operational information to other nodes and networks for the benefit of the ecosystem.

Putting it all together

When dealing with the here and now, a number of projects can be initiated to achieve a more connected and efficient operation in relation to aircraft and ground technologies. First, ensure that the aircraft is connected to the airline ecosystem in a more robust way than via ACARS alone. Current fleet aircraft health monitoring (AHM) systems do a fine job of collecting data from sensors, avionics and systems throughout the aircraft. Architectures vary with aircraft model and vintage, but the main principle boils down to collected operational or monitoring data being transmitted via ACARS from the aircraft to the ground, where this data is collected in a server and managed by an airline department. The data sets themselves are usually standard messages designed by the OEM. In some cases, standard messages have been amended by a third party or the user itself, and in other cases entirely new messages have been designed to enable the collection of more data, or more in-depth data. An example here is the Airbus Report 46, as designed by Swiss Technik, which collects and tailors data on auxiliary power unit (APU) activity. The point is that these messages only convey a very small subset of the vast amount of data that is generated on every flight. Reasons for this trickle of flight operational and health monitoring data are due mainly to the limitations in aircraft system architecture and the transmission costs involved. Both are factors that the industry has learned to live with, but two developments are challenging the status quo:

- Affordable satcom systems for both voice and data, driven by commercial market forces. This method of transmission has made its way into aircraft via the installation of satcom connectivity for in-flight entertainment (IFE). Developments in the satcom world promise high bandwidth at low cost, an ideal conduit for the real-time transmission of large datasets, even video-streaming, at an affordable cost;
- EFBs offer an all-in-one connectivity, computing power and storage solution, and have come a long way from the original aim of moving paper documents to a stand-alone device and running a few non-critical programmes during non-critical flight phases. A few generations, ideas, designations and accepted use methods have come and gone, and EFBs have now taken the role of primary go-to device prior to, during and post flight. This changes the way in which flight crews work and access information, and airlines connect with aircraft data through connected EFBs. It has also led avionics providers to embrace the device to push innovations that would otherwise not be feasible to produce, certify and sell. For example, Honeywell, the designer and producer of the flight management system (FMS) in many aircraft, is developing an in-flight optimisation tool to run on a connected EFB, right alongside the (not as accurate) output of its own FMS!

Having powerful EFBs with a multi-tasking OS connected to the various avionics and systems buses through means of an aircraft interface device (AID) puts a number of multipliers in the cockpit, including: the ability to run and use dedicated weather, performance and optimisation apps that otherwise would never have made it into a cockpit; the ability to do so simultaneously and have another app combine this data and run analyses with yet other output to both screen and airline on the ground; the ability to store vast amounts of data, act as a back-up quick-access recorder (QAR) with more capacity and capability, even to run diagnostics and analyses on the collected data before transmission. These and other capabilities will leverage on-board data and awareness outside of the current channels and inputs, in turn supporting the full spectrum of flight operations and network management in major ways. Developments have only just begun, with thoughts and visions on more complete information distribution and the resulting changes in process management in continuous motion and as varied as the airlines contemplating them.

The future workplace of Flight Dispatch may not be a workplace at all, rather an AI managing a fleet of aircraft creating its own flightplans with continuous in-flight updates throughout a flight.

Mission management

One area where optimised interconnectivity will hugely benefit all key participants in the global aviation ecosystem is mission management, the optimised movements of aircraft (piloted or droned) through space and time without any waste in time, fuel and cost.

Today, individual airlines manage their own fleets as best as they can, aiming to have their aircraft depart on time and arrive on time, without much interaction with their two main partners; airports and air traffic management. It is largely a launch-and-see-how-it-goes exercise where some form of control exists as to departure time and collaboration with departure airports. However, timings of arrivals at busy airports tend to be uncertain, both on a runway and at a gate. Several attempts exists to bring a change to the current situation, where a few Air Navigation Service Providers (ANSP) take the lead in creating time-based operations with the aim of establishing precise on-waypoint operations, which in turn facilitate more efficient arrival sequences and avoid holding delays at busy airports. These attempts are far and few between however, and are limited to partnerships set up for operations on a specific city-pair. They show the way though, and a future can be envisioned where all aircraft within the ecosystem are continuously in (automated) contact with ATC and airports in facilitating the most optimum use of airspace at the most optimum speeds, pro-actively managing departure and arrival sequencing. One can imagine an AI designed to optimise arrivals at a busy hub, where aircraft automatically transmit key performance data related to desired arrival route (or runway, or even gate), gross weight, speed range, and other operational limits or requirements. This data is received by the AI and it will interact with each FMS in setting up the arrival parameters, programming the FMS in fact with the flight crew monitoring intent and results. The AI will provide input in speed-managing inbound aircraft (not a new concept. Sint Maarten (SXM) has been doing this manually for years) in much the same way, attempting to optimise arrival sequencing as much as possible, avoiding waste in time, cost and fuel. For all of this to happen, (inter-)connectivity is key, as are much smarter aircraft talking to much smarter ATC and Airport systems.

It is now accepted that having the ability to port EFBs with aircraft systems has become a business necessity for increased awareness and efficiency. As with other equipage projects, a business case to justify an expensive retrofit will need to show a reasonable return on investment (ROI) period, unless the investment is budgeted under branding or other agreed commercial investments. One way of creating a positive business case is to include a set of tools that will run on the EFBs and help generate cost savings, which in turn negate the projected cost. Examples are current offerings towards in-flight profile optimisation from companies like PaceLabs, Honeywell, Boeing and AVTECH, where tools running on the EFBs are used as a decision-support mechanism for the flight crew in working with the limited capabilities of the on-board FMS (and FMC and FMGC). Other tools focus on optimisation of en-route and descent winds (AVTECH, Boeing), in turn aiming to fly more efficiently. With these and other efficiency-generating tools included in the equipage process, financial risks are limited, and a decision to move ahead with the project can be taken.

Areas not yet much developed include the on-board processing of classic FE data derived from the aircraft data buses, in turn producing an FE scorecard that can be filed as part of other flight documentation. Then there is en-route weather and traffic data, as well as interaction with other traffic and company OCC (why not set up a Whatsapp group for oceanic crossings or LHR arrivals, or for enhanced collaborative design making (CDM). Then there are 3-D enhanced navigational displays that create more situational awareness during descents and approaches or when taxiing around an airport.

The key is to accept that part of the equipment, most notably the EFB itself, should be seen as a temporary device, to be replaced after a period of three to four years, partly because of the expected design lifespan of the device that is used for these applications, but also because expected technological advancements may require newer devices or even an adjusted system architecture.

In closing

There is a plethora of material available in print and on-line concerning topics discussed in this article, and at times it may seem that a choice between systems or operating philosophies is a daunting task. Aircraft Commerce Consulting (ACC) is a provider of aviation consulting services and can support airlines with these topics by performing feasibility studies, helping to define requirements and preparing business cases, helping to produce request for proposal (RFP) documents and supporting subsequent steps in equipage, amending processes and performing training. AC