THE CONNECTED AVIATION ECOSYSTEM

Commercial aviation experts share a vision of a more seamless, efficient and sustainable future.

PRESENTED BY:

Collins Aerospace



LETTER FROM THE EDITOR, RYAN SCHRADIN

Behind nearly every technology and trend that we're seeing in commercial aviation today is the need for connectivity. Whether it's connectivity to the cabin, the cockpit, or network-enabled sensors and devices that measure the health and safety of the aircraft and its engines – the ability to receive and transmit data and information enables nearly every advancement and innovation being introduced to the industry.

One of the companies driving this more modern, connected, and technology-enabled commercial aviation industry is Collins Aerospace.

The company recently introduced a new vision for the future of commercial aviation, called "The Connected Aviation Ecosystem."

In this vision, airlines, flight crews, airports, and passengers reap the benefits of a connected, seamless, paperless passenger journey through the airport. Pilots enjoy the safety, convenience, and efficiency of a connected cockpit and next-generation applications. Additionally, airlines, airports, and passengers alike get to experience a world with fewer flight delays and decreased uncertainty thanks to massive improvements in operations on the ground – including maintenance that starts while the plane is still in the air.

The editorial team at Connected Aviation Today sat down with a number of experts from Collins Aerospace to take a deeper dive into how connectivity, data sharing, and new technology can have a tangible impact on air travel.

During our conversations with these aviation experts, we explored three phases of commercial air travel by following the passenger's journey: through the airport, onto the aircraft, and en route to their destinations. We then explored some of the new technologies that are making this futuristic vision of seamless, efficient, and sustainable air travel possible.

This eBook brings these conversations together to give you a view into what aviation can and will be when connectivity is commonplace and information flows freely across the connected aviation ecosystem.

Sincerely, Ryan Schradin Executive Editor, Connected Aviation Today

TABLE OF CONTENTS

CHAPTER ONE

RETHINKING TODAY'S EXHAUSTING AIRPORT EXPERIENCE

Interview with Tony Chapman, the director of industry affairs, alliances, and strategic initiatives at Collins Aerospace.

CHAPTER TWO

A MODERN APPROACH TO AIRCRAFT MAINTENANCE

Interview with Seth Babcock, technical operations, digital, and data solutions lead at Collins Aerospace.

CHAPTER THREE

ENABLING BETTER, SAFER, MORE EFFICIENT AIR TRAVEL

Interview with Chris Mackey, the general manager for network and connectivity solutions at Collins Aerospace, and Alexis Hickox, the head of product marketing for connected aviation solutions at Collins Aerospace.

CHAPTER FOUR

BRINGING CONNECTED AVIATION TO LIFE

Interview with Jennifer Schopfer, president of the Connected Aviation Solutions business unit at Collins Aerospace.

APPENDIX

Additional information about the technologies and solutions referenced in this eBook.

4

9

23

18

CHAPTER ONE

Rethinking Today's Exhausting Airport Experience

"You have your passport, right?" It was an innocent enough question, but one that sent immediate shockwaves through my system. I had been standing calmly in line, waiting to verify my identity and show my boarding pass to an employee of the Icelandic Transport Authority, when my wife's question split the silence.

This next and final step was the only thing standing in the way of boarding a flight back to the United States. Until this very moment, I was confident in my ability to pass this test with flying colors.

"Do I have my passport?" I asked myself. Panic took hold. I started feeling around anxiously in every pocket of my clothing. My hands darted helplessly and furiously across my pants pockets, the large pouch on the front of my hooded sweatshirt, and the inside pockets of the jacket that covered everything.

To my abject horror, the furious search resulted in nothing but a smartphone, a wallet, a few receipts, and a set of keys.

My imagination started to take hold. I envisioned myself trapped more than 4,500 miles away from home in a foreign land, desperately begging an American consulate to expedite a replacement passport so that I could get back to my life. I envisioned staying in a cheap hotel in Reykjavik for weeks, waiting for faceless bureaucrats thousands of miles away to stamp documents and push papers. I could feel my blood pressure rising along with the temperature as it suddenly became uncomfortably warm. I started to sweat. This was every international travel nightmare I had ever had, and it was coming true.

"Oh wait," my wife said, innocently. "I have it right here, in my purse." I had handed it to her – the more responsible "adult" in the relationship – fifteen minutes prior.

This was an (overly dramatic) retelling of a true story that happened just a few months ago. And it's a story that practically everyone reading this eBook has probably experienced in some way in the past. But what's most horrifying about an experience like the one I had in Iceland's Keflavík International Airport is that it doesn't need to happen at all.

Connected Aviation Today recently sat down with Tony Chapman, director of industry affairs, alliances, and strategic initiatives at Collins Aerospace, to talk about connectivity and new technology in the airport. During our conversation, Tony laid out a vision for the airport of the future – one where passengers are guided effortlessly to their gate without having to repeatedly show proof of identity and other travel documents or keep track of a crumpled piece of paper. A vision in which a simple question from a somewhat forgetful significant other doesn't send us spiraling emotionally and digging through our pockets.

Here is what Tony thinks the airport experience of the future will look like in the Connected Aviation Ecosystem:

Connected Aviation Today (CAT): We've all been to an airport, and we're all aware of the process we have to follow to get from check-in to our seats on an aircraft. How does the check-in and security process impact airport operations? How can it affect airlines? What impact does it have on the passenger experience?

Tony Chapman: Today, most of the check-in process is completed online and via mobile device before the passenger even steps into the airport, but bag drop is certainly a process point that can act as a restriction. In fact, bag drop and security are the two major restrictions -or bottlenecks-in the airport that can delay passengers from getting airside, where they can relax, shop, and dine before boarding their flights.

These bottlenecks can impact airport operations by making passengers late for flights. And, if one person is late or takes a long time in either of these locations, the impact can snowball.

It certainly affects the passenger experience. No passenger wants to miss flights or experience delays waiting for other passengers to make their way to the gate. But it also impacts the airport itself.

There is a correlation between the amount of time spent in security and how much is spent in terminal retail stores and restaurants. If the wait time is too long, spending decreases and stress levels of passengers rise. Not only does that impact the passenger experience, but it also impacts the airport and airlines. It's not seen as good service. CAT: How can biometrics change the way passengers move through airports? What would the airport experience look like if airports were to embrace biometrics?

Tony Chapman: I should begin by noting that for biometrics to be successful, they have to be embraced by both the airports and airlines because they impact all their systems. However, when both come together to implement biometric solutions, much of the process can be done by the passenger at home via their mobile device.

The passenger would enroll via their mobile device at home in advance of their flight. They would then share access to their biometric information with the airport and airlines. Once that biometric data is shared, the rest of the processes – boarding, baggage drop, security – could be much less "high touch" and require very little paper.

With biometrics in place, complicated processes that require passengers waiting in line to show an airport employee or government official their physical documents could be eliminated or expedited. Depending on the country of arrival and its particular rules, there may not be the need for long border control lines and passport checks.

Biometrics could also lead to other technologies and advancements that improve the passenger experience. Passengers could be identified by their biometric data upon entering the airport, allowing them to be seamlessly and individually guided to their next locations – from baggage drop, to security, to their gate of departure. This process could function to make the experience faster while eliminating frustration and confusion on the passenger's behalf.

CAT: What impact would more readily available flight data have on this process? If the airlines had better visibility into their planes – both on the ground and in the air-and more transparency into flight status and timing, how could it impact the operations of the airport?

Tony Chapman: Integrating data feeds from Collins Aerospace's FlightAware acquisition can give airlines and airports more predictability to the arrival and departure times of aircraft. And a clearer, more transparent picture of aircraft location and status can improve operations. Access to this data can enhance the operations of the airport, because there wouldn't be planes waiting in queue to take off or waiting on the runway with no departure windows.

Accurate departure and arrival times allow airlines to predict better – enabling them to work out a defined, compressed schedule that results in more turns from the same gate. As a result, airports subsequently get more capacity from each departure gate. And, perhaps most importantly, passengers get greater predictability into their departure times because aircraft are more likely to be on time.

CAT: How would airline passengers benefit from these proposed changes? Can you walk us through how the passenger experience would improve or change?

Tony Chapman: In the future, with these technologies implemented, everything starts before the passenger leaves their home. They know their flight is on time, because the airline and airport have improved flight status and aircraft location data. They've created their biometric enrollment on a mobile device at home or in their hotel. That's all taken place before they even leave for the airport.

When the passenger arrives at the airport, they know the status of their flight and its projected departure time. The guidance systems applications on their mobile devices show them which path to follow and where to go based on their identity and the flight they'll be taking that day. They'll be identified as they walk in the door and guided to the baggage drop, where the system knows their scheduled flights and issues them a baggage tag. In the future, bag tags will invariably be a thing of the past, as well, but they're still a part of the process today.

From there, the passenger proceeds to a predefined security appointment without a queue to pass through security. The passenger is no longer required to produce a boarding pass or passport because their information is already known via their biometric enrollment.

While they would still need to go through physical security screening, once passengers clear physical security, mobile guidance systems direct them to their terminal and gate where they are free to enjoy themselves before boarding. Any change to the flight would be pushed directly to the passenger via their mobile device.

When it's time to board, they wouldn't need to juggle their carry-on baggage just to show airline personnel their boarding passes and might not even need to show their passports. The entire journey would be less driven by showing multiple paper-based documents to airline employees or security personnel. They wouldn't have to worry about producing them at every touch point.

CAT: What would this mean for flight crews and pilots? What impact would it have on their jobs and their experience?

Tony Chapman: There are two benefits for flight crews and pilots that would make their lives easier and increase efficiency. First, they would also benefit from biometrics in many of the same ways passengers would. Biometric processes could be applied to staff going through security points, could guide them to where they need to be in the airport, and could generally automate much of the process of getting from the airport door to their departure gate.

Second, if flights arrive and depart as predicted, pilots and crews have more transparency into where they need to be and when. This would allow them to optimize their pre-flight activities and make their lives easier.

CAT: It seems like greater predictability might have real benefits for airports. Can you elaborate?

Tony Chapman: By integrating flight data with the airport's building management systems, airports can optimize building management based on predictions of flight crew and passenger traffic. For example, if no flights are scheduled to come through a part of an airport for a period of time, the air conditioning or lighting could be turned down to reduce energy consumption, and help the airport meet its net-zero efficiency targets.

CAT: How do airlines benefit from greater predictability?

Tony Chapman: The airlines can benefit from greater predictability in their operations. If they have a better understanding of when aircraft will arrive and when they need to take off, the airlines can alter their operations accordingly to increase efficiency.

For example, should there be weather en route, airlines can notify passengers far in advance and then reroute subsequent flights around that area. Or, if the airline knows a flight isn't cleared to depart on time, they can delay the pushback to reduce time waiting on taxiways to reduce fuel burn-cutting both costs and minimizing CO2 emissions.

Ultimately, for the airlines, greater predictability results in greater planned performance.

The benefits of the Connected Aviation Ecosystem extend far beyond the passenger experience in the terminal. As the passenger passes through security, through the gate, beyond the jetway, and onto the aircraft, they continue to benefit from a more seamless and efficient experience all because of connectivity.

CHAPTER TWO

A Modern Approach to Aircraft Maintenance

Anyone who has taken a flight for business or pleasure has probably experienced a maintenance-related flight delay. In fact, some passengers may have even had to deplane because a maintenance issue was identified after they boarded and prepared for takeoff.

These maintenance issues have a significant impact on airline operations and a real impact on profitability. Maintenance delays are among the most annoying inconveniences for passengers and can significantly impact brand loyalty – costing airlines future customers and lost revenue.

But what if delays from maintenance problems could be drastically reduced or even eliminated?

To learn more about how new technologies and increased connectivity can enable better, more proactive aircraft maintenance and reduce flight delays, Connected Aviation Today sat down with Seth Babcock, who oversees technical operations, digital and data solutions at Collins Aerospace.

During our discussion, we explored how maintenance problems and delays create downline issues for airlines and how new technologies can reduce unplanned maintenance to lessen the impact on airlines and their passengers.

Here is how Seth thinks a more proactive approach to maintenance and repair can make air travel better for the passenger and more profitable for the airline:

CAT: What are aircraft maintenance and repairs like today? If a pilot senses there's something wrong or experiences a problem on a plane, what happens when they reach the ground?

Seth Babcock: While all airlines are different, most communications to the operations center are primarily handled through the Aircraft Communication Addressing and Reporting System (ACARS). Some airlines have taken the next steps to use these messages to give maintenance technicians some initial insights; however, these messages contain limited data and are of limited use.

While there is an opportunity for airlines to increase the use of ACARS to transmit messages and fault codes, as I've described previously, I would say much of the industry still has antiquated processes in place today. When the pilot lands, he or she contacts dispatch via ACARS to report a maintenance issue. Dispatch then sends a maintenance technician to the aircraft to troubleshoot the issue the pilot has identified.

However, with increased access to broadband and IP connectivity in the cockpit and the installation of Aircraft Interface Devices (AIDs) to move data between the aircraft and ground systems, we will see full flight data become available after every flight.

Access to this larger dataset will allow airlines to take advantage of prognostics and health management (PHM) and engine health management (EHM) systems to predict component failures and provide advanced troubleshooting on complex aircraft systems.

CAT: What impact does a maintenance or repair problem have on flight schedules? Is everything moving forward delayed? How do airlines handle that?

Seth Babcock: An airline focuses on being as proactive as possible. It works to build maintenance programs that proactively identify common operating issues, such as tire wear, brake wear, and fluid servicing, before they become a problem. But even with proactive maintenance, events are unavoidable and can snowball through an airline's entire operation.

For example, the turn time for an aircraft operated by a large airline is approximately 60-70 minutes during heavy travel times, such as the summer. Communicating and getting a maintenance technician to troubleshoot a problem on an aircraft can eat into that window and create a delay almost immediately.

Many airlines have implemented "gate manning" – a technician stationed at the gate tasked with checking in with the pilots as soon as they land to get the tools and parts needed for maintenance and repairs as quickly as possible. Gate manning, with access to ACARS data, is the best solution available now for getting as early a jump on maintenance concerns as possible. However, with full flight data becoming available post-flight, PHM & EHM are poised to change this dichotomy.

CAT: Could a connected aviation ecosystem benefit the process?

Seth Babcock: The goal is to become as proactive and predictable as possible. Airlines are never going to be able to avoid all of the day-to-day delays. However, by focusing on complex system health (such as pneumatics, air conditioning, and flight controls) using full flight data, airlines can minimize many maintenance issues that can cause delays during the operating day. Given that benefit, a few companies, like Collins Aerospace, are currently building PHM tools to develop analytic solutions for these systems.

Additionally, another area that can hinder an airline throughout the operating day is other aircraft interior-related items (tray tables, seatbelts, recline actuators, overhead bins, etc.). Today, these items don't have sensors to provide data in real-time. But companies like Collins Aerospace are working closely on natural language processing (NLP) and text analytics to review handwritten log page data sets to identify chronic interior-related issues.

For instance, I saw a common maintenance theme at airlines: loose tray tables. A couple of set screws on tray tables often loosen, and the tray table will not stay stowed. This problem would happen repeatedly, with the maintenance tech tightening the set screws. An airline could take many instances before they identified this as a recurring problem. However, using NLP text analytics, this issue could be flagged as a repetitive issue much earlier than previously possible, helping avoid future disruptions.

We can also use a hybrid approach to identify maintenance issues by combining the use of flight data and sensor data. For example, we can better understand tire and brake wear by analyzing FlightAware data. We can analyze historical flightrelated data sets (taxi speed, runway length, etc.) and compare that to sensor data to better predict wear and replace parts proactively. This enables airlines to drive work out of the operating day and into the overnight, reducing the potential for maintenance-related delays.

CAT: What impact would this have on the passengers? Would they even notice if systems like a connected aviation ecosystem were put into use? Would they benefit in any way?

Seth Babcock: Absolutely. Most people have boarded an aircraft and been told that a maintenance issue needs to be taken care of before the flight can take off. Now you are delayed until they can look at the problem and close out the issue. In some cases, the plane returns to the gate, the flight is canceled, and passengers are left to scramble for rebooking options.

The goal is to run a safe and reliable airline. We see FlightAware and predictive maintenance as key to enabling airlines to achieve that. And that leads to a better passenger experience.

CAT: How about the flight crew and pilots? What impact would this have on them?

Seth Babcock: The first thing that comes to mind is safety. The most important thing the pilot is tasked with is getting their passengers to their destination safely. Having data analytics available improves both reliability and safety. The more we can predict a failure, the fewer fault codes pilots experience, meaning the fewer problems they must troubleshoot in real time as they fly from point A to point B. Solutions like ours enable maintenance crews to proactively replace components to avoid the fault code altogether.

CAT: Finally, what about the airline? Is there a return on investment for these types of technologies and solutions? What would they get out of adopting these technologies?

Seth Babcock: From a maintenance perspective, aircraft are complex machines. Fault codes have multiple troubleshooting paths, which can sometimes replace incorrect parts. Predictive maintenance proactively removes or replaces faulty parts in ideal scenarios.

However, even when PHM cannot predict a part failure, it can be used as an advanced troubleshooting tool (i.e. pneumatic sense line isolation). This narrows down the problem to a few root causes, allowing specific instructions to be issued instead of going through a lengthy troubleshooting tree, providing airlines with a more accurate solution in a more timely manner.

Flight delays have cascading effects that create downline impacts. It causes airlines to shuffle crews to accommodate schedule changes and rebook passengers. This snowballs quickly and can become very expensive for the airline—which is why implementing a PHM solution can have an immediate payback for an airline and provide a better experience for passengers.

CAT: It's obvious that connectivity and new technologies can improve the passenger experience in the airport, at the gate, and on the tarmac. But do the benefits follow the passenger onto the aircraft and into the air? Our journey continues as passengers take their seats, put their seatbacks and tray tables into the upright and locked positions, and prepare for takeoff.

CHAPTER THREE

Enabling Better, Safer, More Efficient Air Travel

The average commercial airline passenger might be surprised to learn that the broadband connectivity they enjoy using in-flight to watch movies, listen to music, or check in at the office is often not available to pilots and flight crews. In fact, surprisingly, only a small percentage of airlines have extended broadband connectivity beyond the cabin and into the cockpit.

While this may not have been a problem a decade ago when the amount of available data and information being transmitted between the aircraft and ground was more limited, it's certainly an issue today.

With the introduction of the newer generation, data-intensive aircraft, electronic flight bag (EFB) applications, and predictive maintenance tools across the commercial aviation industry, there is now more data available to airlines than ever before. Unfortunately, that data is currently being underutilized since the cockpit connectivity needed by airlines to access real-time information is often limited.

Connected Aviation Today sat down with Collins Aerospace's Chris Mackey and Alexis Hickox to talk about what would be possible if the same quality connectivity was available in the cockpit as in the cabin. During our discussion, we talked about how new connectivity options could power advanced capabilities, explored how aircraft could become safer and more enjoyable for passengers, and identified ways in which this technology would improve operations and make airlines more profitable. Here are their thoughts on how connectivity in the cockpit is beneficial for everyone on the plane – from the flight crew, to the to the passengers and to the pilots.

CAT: How are most cockpits connected today? Are some aircraft cockpits still not connected with high-bandwidth connectivity? What connectivity options are available?

Chris Mackey: All cockpits are outfitted with at least a minimal level of connectivity today, including VHF or HF Voice. This level of connectivity is mainly due to regionally implemented mandates and is primarily used for safety services.

However, today we're seeing a wide range of connectivity media available for the flight deck, including VHF and HF data link services, L-Band and S-band satellite communications, cellular connectivity while on the ground, and next-gen satellite communication.

With the growth of the modern digital aircraft fleet, which has advanced connectivity capability embedded in its flight control systems, it will become essential for the airline to manage flight deck and Aircraft Control Domain (ACD) data within a secure link to the ground. However, there is also an increasing requirement to support a growing ecosystem of electronic flight bags (EFB) and other applications on the flight deck, and many of these will require inflight connectivity with enough bandwidth to support updates and graphical communication from the ground.

The emergence of smart onboard routers and the development of ACARS over IP (AoIP) offer the ability to provide secure routing of data via multimedia. This means that an airline can ensure that safety services and time-critical applications are treated as a priority and can comply with safety mandates while simultaneously routing non-safety traffic.

Since there are different categories of data and information that can be routed in different ways to the ground, the door is now open for airlines to use non-traditional media paths with much higher bandwidth capacity, such as cabin broadband, to complement their flight deck connectivity.

CAT: How could things like EFBs be better and more effective if the pilots and cockpits have high bandwidth connectivity? What new applications and capabilities could be made available in the cockpit?

Alexis Hickox: More than 80 percent of the world's commercial airlines are now equipped with electronic flight bags. The ability to eliminate paper initially drove the adoption of the EFB and has resulted in an overwhelming majority of airlines utilizing the technology. Now, all the information that was available to the flight crew on paper in giant binders is data that can be displayed on a tablet.

The lack of IP connectivity that Chris referenced is a limiting factor for EFBs. It restricts the applications pilots can use and keeps them from accessing real-time information that would be useful for the flight crew – such as up-to-date weather reports or turbulence alerts.

By enabling the flight deck with a secure IP or broadband connection, the aviation industry can unlock the untapped potential for tracking and managing an aircraft more accurately and efficiently.

The recently released Collins FlightHub[™] Electronic Flight Folder (EFF) application is a great example of this. This new solution gives flight crews access to aircraft and performance data at their fingertips. Automated data collection and analysis ensure that information is quickly communicated between dispatch and the flight deck to enhance decision-making.

CAT: Why is an EFF necessary? What does FlightHub do that other EFB applications or systems can't?

Alexis Hickox: It's about getting the right data and information to the flight crew when they need it. EFF solutions like FlightHub streamline the user experience for the flight crew by aggregating data that is currently distributed across multiple applications and presenting it when needed.

With fewer applications to manage, flight plans can be easily adjusted to the most optimal and economic routes to help improve planning and sustainable operations, unlocking the potential for time and fuel savings.

This is where the Collins Aerospace Flight Profile Optimization (FPO) application plays a role. This complementary solution can be combined with FlightHub to enhance airline operations further – using real-time data to identify the best flight path trajectory based on lateral and vertical optimization.

This is important for airlines today. Rising fuel costs and a desire to reduce CO2 emissions are prompting airlines to look at ways to reduce fuel burn to make flights more cost-effective and sustainable. The interactive FPO app enables the flight crew to initiate re-optimization processes by working collaboratively and effectively with the airline's dispatch. But connectivity is needed to unlock these benefits.

CAT: Are there other elements an airline must consider in its operational environment when connecting EFBs and other applications in the cockpit?

Chris Mackey: There is another piece of the puzzle-the ground

management of the connected cockpit and the interconnection of the aircraft with the ground-based systems and applications. The longevity of an aircraft is typically 20 years or more. As a result, airlines will have to continue to manage a mixed fleet of older legacy and new digital aircraft under a similar operational environment for decades. This will make managing data on the ground more challenging, since each airframe can have different protocols from the aircraft and onward to the airline operation center.

Collins offers cloud-based hosting of the applications on the ground, so access to apps like our FPO solution is available to both the dispatch team and the flight crew. The ground-based architecture ensures that all the data relating to weather, aircraft movement, etc., is available to all parties when needed, regardless of aircraft platform or type. Selecting the right partner for a total connectivity solution that offers interoperability on the ground and in the air will be essential to leveraging the most out of the connected aircraft or cockpit.

Airlines need robust ground-based management tools that can handle multiple datalinks, applications and data sources across multiple airframes.

These types of tools (usually delivered via a portal) provide the airline with ground visibility into the wireless transfer of data between the AID and a secure file storage location, and can also provide several administrative utilities, including fleet management, device management, user management, file transfer configuration management, upload to and from aircraft, and other capabilities.

This type of portal also enables closed-loop communication between the aircraft and the ground, including automated and ad-hoc data transfer.

CAT: Should an airline get the cockpit and ground systems right and improve connectivity to the aircraft-what impact would this have on the passengers? Would they even notice if systems like this were put into use? Would they benefit in any way?

Alexis Hickox: The passengers might not know they're benefiting from it, but they would be. Increased connectivity would ultimately deliver significant improvements to the airline's Key Performance Indicator (KPI) applications and services by delivering aircraft, engine, and other system data to the ground.

This would enable real-time diagnostics that would allow airlines to pre-position the right parts, equipment, and personnel at the gate to help make turnaround times faster and keep asset utilization up. Furthermore, this would result in fewer delays and quicker resolutions – getting more passengers to their destinations with fewer maintenance and repair disruptions.

Solutions like FPO can also benefit the passenger. Optimizing the flight path with real-time information and data allows the airline to make better routing decisions to avoid potential weather events that could cause increased turbulence or arrival delays.

CAT: How about the flight crew and pilots? What impact would this have on them? How could increased cockpit connectivity make their jobs better and safer?

Alexis Hickox: It makes their job easier while ensuring they always have the necessary information when needed.

Today, pilots constantly review and share multiple data sources with flight crews and ground operations to ensure they have the correct information at the right time. EFFs, like FlightHub, centralize these data sources and workflows by aggregating them into one single stream to the aircraft, providing fast and simple access to flight information when the pilot needs it. Also, an easy-to-use, intuitive user interface is important because it reduces the complexity of training and creates one standard experience across all aircraft. This makes it easy for pilots to find what they need regardless of the aircraft they're flying.

Finally, there's the safety aspect. Getting access to real-time weather updates and turbulence alerts and optimizing routes during flights could enable pilots to avoid weather that might cause problems for the aircraft. This means safer flights for pilots, flight crews, and passengers.

CAT: Finally, what about the airline? Is there a return on investment for these types of technologies and solutions? What would they get out of adopting these technologies?

Chris Mackey: For the airline, it's about improving efficiency, increasing sustainability, and streamlining operations. Real-time flight data monitoring, quality assurance, exceedance alerts, and fuel use monitoring can help reduce delays and make aviation more sustainable. By reducing delays, the airlines can also reduce compensation claims, unplanned maintenance, and fuel bills and mitigate safety situations.

Pre-flight route optimization and in-flight route optimization are potential game-changers for airlines that can produce quantifiable fuel and time savings, while reducing their environmental impact.

CAT: From the time the passenger drives to the airport to the minute they touch down at their final destination, increased connectivity and new technologies can make their experience better, safer, and more seamless. But what is needed to make this a reality? What new technologies and solutions can bring this vision of the Connected Aviation Ecosystem to life?

CHAPTER FOUR

Bringing Connected Aviation to Life

In the previous three chapters of this eBook, we've featured conversations with four different aviation experts from Collins Aerospace focused on how connectivity and new technologies could revolutionize the entire passenger journey – from check-in to the gate, to the tarmac, and into the air.

Ultimately, these four experts described a new, brighter future for commercial aviation.

A world where passengers weren't fidgeting with paper tickets and passports as they waited in long lines to check in and proceed through security. A world where flight delays due to bad weather or maintenance were mitigated or avoided. A world where flights were smoother, safer, and greener because flight plans were optimized in real time as conditions changed. And where pilots had had all of the information they needed-when they needed it-in the cockpit.

But what technologies are making this all possible? How can we take connected aviation from concept to reality? And what is Collins Aerospace doing to realize a more connected future? To find out, we sat down with aviation industry veteran Jennifer Schopfer, who currently serves as the president of the Connected Aviation Solutions business unit at Collins Aerospace.

Here is how the work of Jennifer and the rest of the Collins Aerospace team is making the Connected Aviation Ecosystem a reality:

CAT: We've had numerous conversations with your associates at Collins Aerospace about how Connected Aviation will transform the passenger experience and how airlines operate. But we've never really asked them to define it. What is your vision? What does it mean for the industry?

Jennifer Schopfer: Connected Aviation involves bringing together billions of data points. These data points are everywhere across the aviation ecosystem – in the airport, on the aircraft, and on the tarmac. They come from radars watching the weather, transponders communicating with air traffic controllers, the sensors that measure the health of airplanes and engines, and the digital records from aircraft subsystems- and so much more.

But we need to take that a step further. It's not enough to simply aggregate and store this data. We need to put this data to use to make every part of the aviation ecosystem better, more efficient, more sustainable, and more convenient for the passenger.

By bringing these billions of data points, patterns, trend lines, and prognostics together and then analyzing them, we can deliver data-derived insights to the right people at the right time. The result is greater efficiency and smoother operations across the industry.

As a full-stack digital solutions provider, Collins Aerospace is uniquely positioned to make this vision of Connected Aviation a reality.

CAT: Let's focus on the connected cockpit and aircraft first. What solutions has Collins Aerospace introduced to help make the aircraft more connected and to enable airlines and flight crews to use their data?

Jennifer Schopfer: There are a number of different solutions that we've innovated for the more connected flight deck. These are designed to increase the amount of data available about the aircraft to those on the ground. They're also designed to make actionable intelligence and information available for flight crews and pilots when needed.

It starts with the next generation of advanced routers and aircraft interface devices that Collins Aerospace has introduced that are making high-bandwidth connectivity possible in the first place. But it extends to the new solutions we've introduced that allow flight crews to employ that connectivity to make flights safer, more efficient, and more sustainable.

Our FlightHub[™] solution, introduced in 2022, is an Electronic Flight Folder (EFF) that is accessible on a pilot's Electronic Flight Bag (EFB). FlightHub centralizes data sources and workflows to combat a real problem facing many pilots: app overload and the inability to find the right data at the exact time it's needed. FlightHub aggregates data sources, such as flight plans, weather information, and

other sources of truth to coordinate the entire flight lifecycle from start to finish. Integrated into FlightHub is another Collins Aerospace innovation - Flight Profile Optimization (FPO). This solution suggests optimal routes during flight to save fuel, time, and CO2 emissions.

CAT: We've all experienced flight delays resulting from aircraft maintenance issues. We've all sat at a gate waiting for our plane to be repaired. In a previous interview with your associate at Collins Aerospace, Seth Babcock, he talked about how predictive maintenance could help change that. How is Collins Aerospace enabling that?

Jennifer Schopfer: Seth is completely correct. One way to minimize delays is through predictive maintenance – and one way to predict maintenance needs is through analysis of aircraft and engine data.

We recently signed an agreement with Pratt & Whitney that will enable them to leverage Collins' GlobalConnectSM solution and Ascentia® analytics full-flight data product to offload that engine health data from the airplane in real time.

The engine health digital services provided by Pratt & Whitney can analyze data from the assortment of sensors on an engine. For example, the Pratt & Whitney geared turbofan (GTF) engine can generate four million data points per flight. Maintenance teams can use those data points to determine days in advance when they'll need to fix or replace a part. This collaboration will enable the more effective and proactive maintenance of engines.

That kind of predictive analysis allows for better planning; operators can even proactively schedule those repairs in the best locations – a major airport with a hangar and plenty of mechanics rather than a remote outpost with limited resources.

Moving forward, the predictive maintenance picture will only become clearer as more data is unlocked from engines, and as the adoption of technologies such as Pratt & Whitney's Advanced Diagnostics and Engine Monitoring data analytics platform grows. But this kind of predictive analytics and maintenance isn't limited to the engine. Collins Aerospace is using its Ascentia platform to predict maintenance needs across the aircraft.

Through statistical analysis, machine learning, and modeling, the Ascentia platform analyzes flight operations and maintenance data, predicts the health of the aircraft and its Collins-made components, and prescribes the best course of action for everything it monitors. Ascentia also is used to normalize aircraft sensor data on more than 2,500 aircraft across more than 60 airlines. This data is then returned to the airline in a self-serve, multi-tiered platform where it can be analyzed and configured to alert on user-defined logic.

These predictive and proactive maintenance programs are being extended across the aircraft to ensure that everything works as it should and the passenger experience isn't negatively impacted. For example, the Collins Connected Aviation Solutions team is partnering with other groups from across Collins to define smart product strategies for a number of different parts and components of the aircraft. They're working with our interiors division on Smart Galley inserts that will alert the airline when a coffee pot malfunctions so that passengers will always have access to a hot cup of coffee when they want it.

While that seems like a somewhat insignificant initiative, it can have a big impact on the passenger experience and how much they enjoy their flight. It's also an excellent example of how we continue to partner across our own organization to introduce more real-time data analysis and more products that come out of the box with predictive maintenance and our Ascentia Prognostics and Health Monitoring (PHM) solutions enabled.

The end result is maintenance that is optimized by occurring in more convenient locations and at predictable times. This optimization helps eliminate surprises and delays – cutting costs for the airlines and improving the passenger experience.

CAT: Passenger experience is certainly important. And I think it's safe to say that – for the average passenger – the airport experience is one of the worst parts of their vacation or business travel. We heard your associate, Tony Chapman, discuss how biometrics could improve that. How is Collins Aerospace making biometrics possible?

Jennifer Schopfer: Airport check-ins, baggage drops, security checkpoints, and passenger boarding processes are usually the last, significant inconvenience that passengers face before they get to relax on a tropical vacation or close a deal on an important business trip. We understand. We fly too.

And Tony is right, of course. Biometric technology can allow passengers to expedite all those processes by simply using their facial scan or fingerprint in lieu of a printed form of ID. But there is more to biometrics than just identification and security procedures.

For example, for travelers that have opted-in, biometric identification technology coupled with better data analysis at airports can direct passengers to alternate security checkpoints to avoid delays. It could be used to provide personalized instructions and directions, eliminating the confusion that can accompany a trip to the airport.

Our ARINC SelfPass[™] biometric solution is already in use at Haneda Airport, one of the busiest airports in Asia. Just last summer, Haneda Airport installed almost 100 self-service check-in kiosks, dozens of biometric enrollment kiosks, over 100 biometric devices for self-bag drop, biometric automated security gates, as well as biometric - automated self-boarding gates to expedite the passenger journey through the airport and make that journey more seamless.

CAT: So, we've talked about the impact of Connected Aviation on aircraft maintenance, airline operations, and the passenger experience. Why is it so important for airlines and airports to embrace the digital transformation that we're seeing in the aviation industry? What trends are making this essential for them today?

Jennifer Schopfer: Ultimately, the different stakeholders that comprise the aviation community – the airports, airlines, ATC, and flight crews-are all facing continued challenges.

Harnessing the digital revolution within the aviation industry and embracing Connected Aviation can help these stakeholders in the aviation industry face these new challenges. Increasing their operational efficiency will enable them to better compete in a crowded marketplace. It will enable them to service more passengers while still delivering a better passenger experience. And it will enable them to meet the aggressive "Net Zero" carbon emissions goals that we're seeing across the aviation industry.

Times like these require creative, innovative solutions to help manage costs and increase efficiency, and that's exactly what our new technologies are enabling. For example, aircraft brake wear is a costly challenge for airlines. Factors like temperature and behaviors such as speed can impact how quickly brakes wear and can be difficult for airlines to predict.

To tackle this problem, our Collins Connected Aviation Solutions team partnered with our Collins Wheels and Brakes group to leverage FlightAware data to pinpoint operating behaviors that were negatively impacting brake life. In mere months, the teams jointly defined, built, and released an analytical solution for an airline customer that is helping extend brake life for their operations. As you can imagine, optimizing maintenance and elongating the life of parts like brakes are critically important to our customers given the challenges facing the aviation industry over the last several years.

Together with our customers, Collins is tackling the toughest challenges in our industry and bringing continuous innovation to the aviation ecosystem to increase efficiency, sustainability, and safety.

Increased connectivity to the cabin, the cockpit, and the sensors within the aircraft is foundational for every new innovation and technology being introduced to the commercial aviation industry today. To stay informed about the exciting new technologies that have the potential to revolutionize the aviation industry, subscribe to Connected Aviation Today at www.connectedaviationtoday.com.



Connecting the Digital Aviation Ecosystem

The proceeding conversations highlight some of the direct benefits that intelligent data and connectivity can deliver to aviation operators and passengers alike. The experts mentioned several technologies and solutions that are available today. You can learn more about them here.

Advanced Diagnostics and Engine Monitoring (ADEM) - An advanced diagnostic tool created by Pratt & Whitney that helps operators better monitor and maintain their engine fleets. ADEM manages real-time commercial engine health data that is transmitted to the ground during flight, providing the ability to spot operational trends and maintenance issues early. Users can utilize ADEM to monitor engine performance internally, or through a team at Pratt & Whitney that monitors and analyzes the data.

ARINC SelfPass[™] - A secure biometric solution and self-service airport product that enables travelers to experience a contactless airport journey all the way from check-in to boarding. This system creates a contactless journey for passengers by leveraging a single - token ID driven by secure biometrics. SelfPass can be applied to multiple points in the process, including check-in, immigration and security, lounge access, and boarding.

Ascentia Analytics Services® - A data aggregation and analysis solution that delivers actionable aircraft maintenance and service insights to airlines. This solution provides full flight data, condition monitoring reports, and fault messages. It is also capable of delivering airline operations data, including utilization, maintenance records, removals, schedule interruptions, flight routes, and inventory – as well as repair data, including as-received tests, inspections, and shop findings.

FlightAware FirehoseSM - An enterprise-grade, real-time data feed of global aircraft ADS-B positions and flight status. Every Firehose connection includes airborne or surface position data from FlightAware's terrestrial network of ADS-B receivers and delivers FLIFO data, predicted ETAs, block events, extended flight information, and weather data to airlines.

FlightAware ForesightSM - Predictive technology that leverages multiple data sources to provide actionable insights and forecast future events for airlines. Utilizing flight track and timestamp statistical analysis of hundreds of thousands of flights in the air, en route, on the ground, and pertinent weather data, Foresight's advanced machine learning models identify key influencing factors for any flight to predict events in real time. This delivers accurate time predictions to aircraft operators and airports, which can enable them to increase efficiency and sustainability, while reducing the cost and impact of delays.

FlightHub[™] Electronic Flight Folder - A recently-released Electronic Flight Folder (EFF) solution accessible from an aircraft's Electronic Flight Bag (EFB) that centralizes data sources and workflows for pilots and airlines, coordinating the lifecycle of an entire flight from start to finish. This EFF solution puts the information that pilots need directly at their fingertips when they need it – ensuring that they don't have to go hunting for essential information across multiple EFB applications when time is of the essence. FlightHub gives users fast and easy access to a wide ecosystem of flight information, from pre-flight documents, like flight plans and weather information, to post-flight summaries with actual timing and fuel burn reports.

FlightHub[™] Flight Profile Optimization - A flight path optimization tool that is built into the FlightHub EFF solution, Flight Profile Optimization (FPO) leverages flight path information taken from multiple aircraft and ground sources to deliver real-time route recommendations throughout a flight to help airlines increase efficiency, reduce fuel costs, and decrease CO2 emissions.

GlobalConnect[™] - A managed digital service that enables a single communications solution in which new Internet Protocol links-such as broadband satellite, Wi-Fi, or cellular-work seamlessly and interchangeably alongside the legacy Aircraft Communications Addressing and Reporting System (ACARS). This service enables the highly secure, bidirectional exchange of data between the aircraft and ground operations, including aircraft maintenance and performance data, and supports data feeds to the growing number of mobile applications that are being used by flight crews.

For additional information on any of these technologies and solutions reach out to Collins Aerospace at commercial-aviation@collins.com.